THE

REPERTORY

OF

ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

2713

VOL. III.

LONDON:

PRINTED BY NICHOLS AND SON,
RED-LION-PASSAGE, FLEET-STREET,
FOR, AND SOLD BY, THE PROPRIETORS, NO. 182, FLEET-STREET; WHERE COMMUNICATIONS FOR THIS WORK ARE REQUESTED TO BE ADDRESSED.

1800.

CONTENTS

OF THE

THIRD VOLUME.

Page

I. Specification of Dr. WILLIAMS's Patent for a Mortar, or Stucco, for Buildings, — — 1

II. Specification of Mr. LUKIN's Patent for Boats, and ſmall Veſſels, that it will neither overſet nor ſink, — — — 10

III. Specification of Mr. POULAIN's Patent for tinning, or lining, Veſſels made of Copper, or other Metals, — — — 12

IV. Deſcription of a Pendulum on a new Conſtruction; by the Rev. Mr. PINE, — — 15

V. Account of a Spontaneous Inflammation, which happened at Spalding, in Lincolnſhire, — 19

VI. Account of a Spontaneous Inflammation, which happened in India. By ISAAC HUMFRIES, Eſq. 21

VII. Account of a Chamber Lamp-furnace. By ROBERT PERCEVAL, M. D. — — 24

Page

VIII. Obſervations on pruning Orchards. By THOMAS SKIP DYOT BUCKNALL, Eſq. — 31

IX. Obſervations on watering Meadows. By Mr. THOMAS DAVIES, — — — 43

X. Deſcription of a Mill to grind Potatoes, and of the Method of preparing Starch or Flour from them. By M. BAUMÉ, — — 62

XI. Specification of Mr. BLAIKIE's Patent for a Subſtitute for Gum, — — — 73

XII. Specification of the Right Honourable H. S. CONWAY's Patent for adapting the Heat ariſing from Coke-ovens to many uſeful Purpoſes, 75

XIII. Specification of Mr. CARTWRIGHT's Patent for Bricks, Stones, &c. on a new Principle, 84

XIV. Farther Conſiderations on the Pangraph. By THOMAS NORTHMORE, Eſq. — — 91

XV. Obſervations on Spontaneous Inflammations, &c. By the Rev. WILLIAM TOOKE, F. R. S. &c. 95

XVI. Deſcription of a Crane for Wharfs. By Mr. JAMES WHITE, — — — 113

XVII. Deſcription of a Pump-Engine. By Mr. BENJAMIN DEARBORN, — — 119

XVIII. Concluſion of Mr. DAVIES's Obſervations on Watering Meadows, — — 123

XIX. Experiments on the Means of improving the Veſſels uſed in Cooking. By Mr. SVEN RINMAN, — — — 134

XX. Specification of Mr. CONNOP's Patent for a Machine for batting Cotton and Wool, — 145

XXI. Specification of Mr. MILES's Patent for making Lamps, ſo as to give perfect Light, though ever ſo much agitated, — — 151

XXII.

Page

XXII. Specification of Meſſrs. ROBERTS and DIGHT's Patent for laying Paint in a Way not yet known and in Practice, — — 159

XXIII. Deſcription of a Method of preventing Injury to the Health of thoſe employed in carding Cotton, — — — 162

XXIV. Attempt to obtain practical Standards for adjuſting the Weights and Meaſures of this Kingdom. By SAMUEL MORE, Eſq. — 165

XXV. Deſcription of a Fire-Engine on a new Conſtruction. By Mr. BENJAMIN DEARBORN, 174

XXVI. Experiments and Obſervations on the Diſſolution of Metals in Acids, &c. By JAMES KEIR, Eſq. — — — 177

XXVII. Concluſion of Mr. RINMAN's Experiments on the Means of improving the Veſſels uſed in Cooking, — — 194

XXVIII. Specification of Mr. TUCKER's Patent for tanning and making Leather of a ſuperior Quality, and in leſs Time than uſual, — 217

XXIX. Specification of Mr. FULTON's Patent for working Pumps, Rubbing-boards, &c. by Means of a Cylinder, — — 220

XXX. Specification of Mr. FISHWICK's Patent for a new Method of making White-lead, — 225

XXXI. Specification of Mr. TAYLOR's Patent for caſting, nealing, tinning, and finiſhing, Iron Pots, &c. 231

XXXII. Deſcription of a ſimple Inſtrument for taking perpendicular Heights, without Calculation, 234

XXXIII. On Irrigation, or watering Land; with Obſervations on Reſervoirs. By WM. PITT, Eſq. 239

XXXIV. Deſcription of two Pendulums; with an Account of a Clock, &c. By Mr. JOHN CROSTHWAITE, — — — 254

XXXV.

Page

XXXV. Continuation of Mr. KEIR's Experiments and Observations on the Dissolution of Metals in Acids, &c. — — — 262

XXXVI. Experiments to discover what Kind of Steel is most fit for receiving the magnetic Power. By M. BRISSON, — — 276

XXXVII. Description of the Machine for kneading Dough, used at Genoa, — — 283

XXXVIII. Specification of Mr. CORT's Patent for preparing, welding, and working, various Sorts of Iron, &c. — — 289

XXXIX. Specification of Mr. PLAYFAIR's Patent for constructing Locks for navigable Canals, 303

XL. Specification of Mr. WATTS's Patent for making small Shot without the usual Imperfections, 313

XLI. Specification of Mr. JACKSON's Patent for beautifying, and preserving, all Sorts of Wood, &c. 316

XLII. Method of vein-marbling, and staining, Silk, Linen, Cotton, Paper, &c. By Mr. TOPLIS, 319

XLIII. Method of sweeping narrow Chimneys, without employing Children, — — 322

XLIV. Conclusion of Mr. KEIR's Experiments and Observations on the Dissolution of Metals in Acids, &c. — — — 325

XLV. Description of a Mercurial Level. By ALEXANDER KEITH, Esq. — — 338

XLVI. Description of a Pentrough for equalizing Water on Water-Wheels. By GEORGE QUAYLE, Esq. — — — 343

XLVII. Method of preparing Naples Yellow. By M. COURET, — — — 349

XLVIII. On the Mechanism of Felting. By M. MONGE, — — — 351

Page

XLIX. Specification of Mr. CORT's Patent for ſhingling, welding, and manufacturing, Iron and Steel into Bars, Plates, &c. — 361

L. Specification of Mr. BRAMAH's Patent for Improvements and Additions to a Fire-Engine, — 368

LI. Specification of Mr. HOOPER's Patent for making Printing-Paper, particularly for Copper-Plate printing, — — — 377

LII. Specification of Mr. ANGELL's Patent for Britannic Elaſtic Gum, — — 381

LIII. Experiments and Obſervations on the Potatoe-Root. By GEORGE PEARSON, M. D. — 383

LIV. Deſcription of a Steam-Engine. By JOHN COOKE, Eſq. — — — 401

LV. Obſervations on draining Land. By Mr. JOHN WEDGE, — — — 405

LVI. On giving to Horſes, in Mills, &c. a perpendicular Draught. By M. BAILLET DE BELLOY, 422

LVII. Concluſion of M. MONGE's Obſervations on the Mechaniſm of Felting, — — 429

PLATES

PLATES

IN THE

THIRD VOLUME.

	Page
1. Pendulum on a new Conſtruction, — —	18
2. Chamber Lamp-furnace, — —	30
3 and 4. Mill to grind Potatoes, — —	72
5 and 6. Bricks, &c. on a new Principle, —	90
7. Crane for Wharfs, — —	118
8. Pump-Engine, — — —	122
9 and 10. Machine for batting Cotton and Wool,	150
11. Method of preventing Injury to thoſe who card Cotton, — — —	164
12. Fire-Engine on a new Conſtruction, —	176
13. Manner of working Pumps, &c. by a Cylinder,	224
14. Inſtrument for taking perpendicular Heights,	234
15. Pendulums, &c. — —	260
16. Machine for kneading Dough, —	288
17 and 18. Locks for navigable Canals, —	312
19. Mercurial Level, — —	342
20. Pentrough for equalizing Water on Water-wheels,	348
21 and 22. Improvements and Additions to a Fire-Engine, — — —	376
23. Steam-Engine, — — —	404
24. Method of giving to Horſes a perpendicular Draught,	428

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XIII.

I. *Specification of the Patent granted to* RICHARD WILLIAMS, *of New Compton-ſtreet, Soho, Doctor of Phyſic; for his Invention of a Mortar, or Stucco, for the Uſe and Purpoſe of Buildings.*

Dated Dec. 11, 1780.—Term expired.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, he the ſaid Richard Williams doth hereby deſcribe and aſcertain the nature of the ſaid invention, and in what manner the ſame is to be performed, as follows; that is to ſay, the mortar, or ſtucco, is made up of the following ingre-

dients; viz. of ſharp, rough, large-grained, ſand, ſifted, waſhed, dried, and freed from all impurities; of well-burnt lime, flaked, and finely ſifted; of curd, or cheeſe, produced from milk; (the firſt freſh-made and ſtrongly preſſed, to diveſt it of its whey; the ſecond, whilſt perfectly ſound, raſped into powder with a grater, or brought into a very light ſubſtance with ſcrapers, or fine-toothed plane irons, in a turner's lathe); and laſtly, of water in its natural ſtate in the under proportions; viz. the cheeſe, or curd, four pounds; the lime twelve pounds; the ſand eighty-four pounds; the water ten pounds; note, if the ſand is not thoroughly dried, or the lime has got damp from the air, the quantity of water muſt be leſs than the above proportion; and, on the contrary, when the lime is uſed as ſoon as flaked, it may require more; ſo that the proper ſtiffneſs of the mortar, under thoſe circumſtances, will be the rule of government. It muſt be made of as hard a conſiſtence as will conveniently admit of laying the firſt ſtages of the work with little trowels in ſmall quanties, to give it the better chance of ſticking well, by preſſing it ſtrongly, whether for filling up the hollows

of

of the walls, or very thinly ſkinning over the projections of the bricks, by way of preparation for receiving the coat or coats deſigned to go on them; for which large trowels muſt be employed, with ſuch portions of the mortar as will not deſtroy the force required to drive it into the walls to make the work firm and ſound, and not in great quantities at a time, as is the uſual practice with other ſtuccoes made ſoft and thin for that purpoſe; which method, if purſued on this mortar, will ſubject it to ferment, ſway, and fall from upright walls before it could ſet, and alſo prevent it ever after acquiring that degree of ſtrength and hardneſs as if it had been laid ſtiffer. However importunate the workmen may be, for their own eaſe, to have this conſiſtence lowered, it muſt not be complied with, for the above reaſons; and, as they may be equally deſirous of firſt grouting the walls with it reduced ſtill thinner, to lay with a bruſh, as is often done, this muſt alſo be abſolutely denied them; as, like a rotten foundation, this grout would ſoon give way, and carry every thing depending on it with it. But if, in laying the firſt coat, it is found in practice not to ſtick well to the projecting ends,

 or

or other parts, of very hard-burnt bricks, without being firſt properly prepared to receive it as the hollow parts have been, in the place of grouting, rub off the duſt, or looſe particles of dirt, with a clean hard bruſh, without wetting the bricks, and then cover them with the mortar in its thick working ſtate, by uſing very ſmall quantities at a time from the point of the trowel, with a ſtrong preſſure, to ſpread it as thin as poſſible, that it may be effectually rubbed into, and catch hold of, their more ſlippery or vitrified parts, which their dry ſtate will contribute to, as their abſorbing power thus will be fully preſerved; and wetting them, either with ſimple water alone, or water mixed up with the mortar into a grout, would deſtroy it. If this is done at the time of filling up the hollows of the walls, or afterwards when the firſt coat is laying, (if more than one is intended,) and no other mode of practice in its place, as a preparation of the walls for receiving the coat or coats on it, the whole work will be ſecured from danger; and its ſtrength, hardneſs, and durability, with every other requiſite, effectually obtained, if the walls prove ſound, and otherwiſe proper to receive

it.

it. But, as the certainty of this ſucceſs will in a great degree depend on the mode of laying and finiſhing the laſt coat, it being known not to admit of wetting, the uſe of the common wood floats muſt be forbid; as their coarſe-grained ſurface, and the cloſe adheſive quality of the mortar, prevent their freely paſſing over it without that aid, and occaſion their wriggling motion in working to detach its parts from each other, and to change it from a ſolid to a ſpungy ſubſtance, by creating innumerable cells therein, in which rain and dews would unavoidably lodge, inſtead of gliding from it, as from the hard and ſlippery face produced by finiſhing with the trowel, or lignum-vitæ floats, which have been contrived for this purpoſe, and admit of the ſame degree of preſſure as the trowel, in uſing them, without injury. As the goodneſs of this mortar depends on the preſervation of the natural properties of the cheeſe, or curd, made uſe of, all thoſe parts the leaſt tainted or rotten muſt be rejected; and as the cheeſe, like the curd, produced from ſkim-milk, is diveſted of its buttery and oily particles, and, on that account, poſſeſſes a powerful coheſive quality, which makes

it

it better for this work than that made of milk in its rich and pure ſtate, and is at all times to be bought of the wholeſale cheeſemongers at a lower price than any other, and being more convenient than the curd, as that will require frequent making, it is to be preferred to it, as well as to every other ſort of cheeſe, as leſs of it does, only four pounds being allowed to the net hundred weight of all the ſolid ingredients; more than which might make the mortar too lively to keep in its place without bagging, but leſs ſhould not be uſed, as that, on the other hand, would endanger its drying looſe and gritty within its ſurface, and hinder its ſticking properly to the walls, and thus bring it back to the level of common mortar. All the articles are to be brought into a well-incorporated maſs, in the manner of tarras, with a heavy beater; and, when deſigned for finiſhing coats of incruſtations, the whole ſand intended for that purpoſe ſhould be dried in ſtoves, or on the floors of rooms where there is a thorough air, of which many parcels may be diſpatched in a few days, if whilſt wet it is paſſed through ſieves to lay it of an even thickneſs, and moved with a garden-rake once or

twice

twice a day, and, when dry, ſwept to a corner to lay on another floor of it, and ſo continued till the whole quantity required is obtained. Lime alſo varying in ſtrength, as it is more or leſs burnt, ſuch as is to be uſed with this ſand for finiſhing ſhould be ſlaked ſome days before the intended time of making it into mortar, when it ought to be well tumbled and mingled together, to bring the whole to one colour and quality, and then ſifted and put into dry caſks, to preſerve it from the dampneſs of the air. And, as there will always be a difference in the dryneſs of the cheeſes, as well as between their rind and crum, which makes them of different ſtrength, they likewiſe ſhould be kept in large quantities ready ſcraped, which, by mixing, will become of one quality; and, if the water is weighed out alike for each gauge, and the mortar (made with theſe ingredients) uſed up within forty-eight hours after, and not left longer to require freſh beating or more water, it is very certain that the fronts finiſhed with it will be of one uniform colour, as the action and power of the rain, air, and ſun, in the bleaching of it, will be throughout the ſame; but if

if the mortar ſhould ever be required darker or lighter, or to ſet quicker or ſlower than the before-ſpecified ingredients will do alone, pit-coal, or its aſhes, and baked or raw plaſter, from the weight of the cheeſe up to that of the lime, will produce thoſe effects. To preſerve this mortar during the forty-eighty hours freſh and fit for working, it ſhould be kept in boxes, of a ſize only large enough to conveniently hold one ſingle gauge or making, with lids deeply rabbeted to enter pretty tight within, and to hang over the ſides without, to keep off the air and rain; beſides which, more effectually to perfect the ſame deſign, double or treble folded coarſe cloths, that have been thoroughly ſoaked in water, and wrung to a moderate degree, that it may run out from them, are to be laid cloſe and tight over the mortar; and if, through neglect at any time, this ſhould be omitted, the cruſty coat that it will have acquired, for want of that covering, ſhould be ſtripped off and thrown away. The mortar, taken from theſe boxes on boards to mount it on the ſcaffold, ſhould be lodged, on the ſame boards, in other boxes kept empty there, to receive and ſhelter it from wind

or

or rain, and the plafterers hawks charged with the mortar thence as wanted, which will greatly facilitate its working; care fhould be taken to ufe the whole mortar of one making, or to empty the box of its remainder, before a frefh gauge is put into it, to prevent the quality of any part of it from being hurt by age. All the boxes, the hods, or other veffels or inftruments made ufe of, fhould be cautioufly attended to, to keep them free from filth, or crufty mortar, left it gets into the frefh makings, which would injure any of the branches of building where it may be employed; whether for laying bricks or ftone, water-fences, floors, copeings, pointings, plafterings, incrufta-tions, and fuch like works, or the forming tiles, ftones, mouldings, or ornaments of any kind; and therefore, if perfection is wifhed to be ob-tained, this, and all other rules laid down, fhould be ftrictly complied with. In witnefs where-of, &c.

II. *Specification of the Patent granted to Mr.* LIONEL LUKIN, *of Long-Acre, in the Pariſh of St. Martin's in the Fields, Coachmaker; for his Improvement in the Conſtruction of Boats and ſmall Veſſels, ſo that they will neither overſet nor ſink.*

Dated November 2, 1785.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Lionel Lukin do hereby declare, that my ſaid invention of an improvement in the conſtruction of boats and ſmall veſſels, for either ſailing or rowing, which will neither overſet in violent gales or ſudden guſts of wind, nor ſink if they ſhould by any accident be filled with water, is deſcribed in manner following; that is to ſay, to the outſides of boats and veſſels, of the common or any other form, are projecting gunnels, ſloping from the top of the common gunnel, in a faint curve, towards the water, ſo as not to interrupt the oars in rowing; and, from the extreme projection, (which may be greater or leſs according to the ſize and uſe the boat

boat or veſſel is intended for,) returning to the ſide in a faint curve, at a proper diſtance above the water-line. Theſe projecting gunnels may be made ſolid, of any light materials that will repel the water, or hollow and water-tight, or of cork, and covered with thin wood, canvas, leather, tin, or any other light metal, mixture, or compoſition. Theſe projections are very ſmall at the ſtem and ſtern, and increaſe gradually to the dimenſions required; they will effectually prevent the boat or veſſel from being overſet by ſudden ſqualls, or violent gales of wind, either in ſailing or rowing, or by imprudent or unſkilful management. In the inſide at the ſtem and ſtern, and at the ſides, (where the projecting gunnels are not neceſſary,) and under the ſeats and thwarts, are incloſures, and bulk-heads, made water-tight, or filled with cork, or other light materials that will repel the water: the ſpaces between the timbers may in like manner be filled up. By this means the boat or veſſel will be ſo much lighter than the body of water it muſt diſplace in ſinking, that it will with ſafety carry more than its common burthen, though the remaining ſpace ſhould by any accident be fill-

C 2 ed

ed with water. Under the bottom, along the centre of the keel, is affixed a falſe one of caſt iron, or other metal; this will ſtrengthen and protect the bottom from injury, in many caſes; and, by being placed ſo much below the ſurface of the water, will act as ballaſt with more power than a much greater weight in the common ſituation, and is much more ſafe, by being fixed in the proper place, and not liable to ſhift by any ſudden motion of the boat or veſſel. In witneſs whereof, &c.

III. *Specification of the Patent granted to Mr.* JOHN POULAIN, *of Mortlake, Surrey; for his Invention of a new Compoſition for tinning, or lining, all Veſſels, made of Copper, Braſs, Iron, or other Metals, eſpecially thoſe uſed for culinary Purpoſes.*

Dated September 13, 1785.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, and in purſuance of the ſaid ſtatute, I the

the ſaid John Poulain do hereby declare that the following is a particular peſcription of the nature of my ſaid invention, and in what manner the ſame is to be derformed; that is to ſay; take grain-tin one pound, good malleable iron one ounce and a half, platina one drachm, ſilver one penny-weight, gold three grains; the whole well fuſed together in a crucible, with one ounce of pounded borax, and two ounces of pounded glaſs; when it is well fuſed, caſt it in ſmall ingots. The compoſition, to be fit for uſe, muſt be heated and put in a metal mortar, alſo heated over a fire, and well pounded with a heated metal peſtle; when it is well pounded make an ingot of it, by putting it on the fire in a mould made of iron plate, in which mould the compoſition muſt be well ſtirred and let to cool, then it is fit for uſe. To apply the compoſition, firſt tin the utenſil or veſſel with grain-tin and ſal-ammoniac, as is uſually done in the common way of tinning; clean well the tinned part of the metal utenſil or veſſel, and then apply a coat of the compoſition with ſal-ammoniac, as is uſually done in the common way of tinning; and, when the compoſition is well ſpread,

ſpread, let it cool; then make it a little red-hot in all its parts, to neal it, and plunge the metal utenſil or veſſel, while yet hot, in cold water; then, with a ſharp ſcraper, ſcrape and rub off the rough or grumous particles of the compoſition applied on the metal utenſil or veſſel, and ſcour it well with ſand. The ſame operation muſt be repeated for every coat of the compoſition that is applied; two coats of the compoſition are quite ſufficient for culinary utenſils or veſſels, and a thin coat of grain-tin may be applied over the laſt coat of the compoſition, to ſmooth it. Charcoal-fire is preferable to any other fire to apply the compoſition with.

N. B. The above compoſition may be applied or uſed for lining, as alſo for covering or plating, the ſurfaces of all materials made of copper, braſs, iron, and other metals, or mixture of metals. In witneſs whereof, &c.

IV. *Deſcription of a Pendulum on a new Conſtruction; invented by the Rev.* J. PINE, *of Eaſt-Down, near Barnſtaple, Devon. Communicated to the Editors by the Inventor.*

WITH A PLATE.

THE great difficulty of adapting different metals to counteract each other, (and which can be effected only by a long courſe of experiments,) enhances the expence of the gridiron-pendulum to ſuch a degree as to preclude its uſe, except in clocks of the firſt expence. This induced me to conſider whether a more ſimple one might not be contrived, with only one metal, founded on this theory; viz. that if two pieces of the ſame metal could be procured, ſimilar in every reſpect to each other, they would expand or contract in the ſame proportion, if expoſed to the ſame degree of heat or cold at the ſame time. On this principle, I cauſed two iron rods to be cut from the ſame

fame coil of large iron wire, which, being drawn through the fame hole, would moft probably contain the fame quantity of metal, &c. To the end of each I had a piece of fteel-fpring fixed, as ufual to common pendulums. On the back of the clock-cafe, which is made of mahogany, I fixed a brafs plate, having two brafs cocks riveted to it, (fee Plate I. AA,) each of them having an upright iron fpill, four or five inches long, round which is wound a fpiral wire-fpring; acrofs thefe, and bearing on the top of the fprings, is a bar, marked B. To the center of this bar, on the back part of it, is fufpended one of the rods, in the fame manner as pendulums are ufually fufpended; the other end is fixed to the clock-cafe, by means of a piece of brafs, through which it paffes, firft fcrewed to the cafe, as at D, and the rod fixed therein by a fcrew preffing tight againft it; by which means the point of fixure can be eafily varied, fo as always to correfpond in length with the pendulum. It is evident that the bar B will always have a tendency upwards, on account of the fprings, but will be reftrained by the rod; confequently, as that expands or contracts, the bar will rife or fall.

To

To the other ſide of this bar is hung the other rod, which, with its bob, forms the pendulum; but a piece of braſs, C, is ſcrewed to the plate, at a proper diſtance below the bar of ſuſpenſion, like a pendulum-cock, through the ſlit of which the pendulum-ſpring paſſes, which confines the point of vibration. The bob alſo is fixed to the rod at the centre E, not at the bottom, conſequently will expand equally in every direction.

N.B. The length of the pendulum, from the point of ſuſpenſion to the centre of the bob, ſhould be as exactly ſimilar as conveniently can be to that at which the regulating rod is fixed by the ſcrew; but it is not found that a trifling variation ſenſibly affects the time. If the pendulum is lengthened by heat, from the point of vibration C, the regulating rod will alſo be lengthened, and, by the action of the ſpiral ſprings, raiſe the ſuſpending bar; ſo that the diſtance, from the point of vibration to the centre of the pendulum bob, will be the ſame as if no ſuch expanſion had taken place. One of theſe pendulums may be con-

 ſtructed

ſtructed for a guinea and a half, or two guineas, and applied to any clock already made, with equal effect as the gridiron-pendulum, which coſts from twelve to twenty-five guineas.

I have had a regulator conſtructed on this principle between four and five years; and, by the niceſt obſervation, can find no variation in the time it keeps. An index is fixed to it, which ſhews the variation occaſioned, in the real length of the rods, by heat and cold, which conſtitutes it a metal thermometer, of ſo ſenſible a nature that, on opening the caſe in extreme froſty weather, it has been obſerved to vary four degrees in leſs than a minute. Yet neither that, nor the ſevere cold laſt winter, nor the extreme heat of a hot-houſe, in one of our hotteſt ſummers, produced any ſenſible variation in the time the clock kept.

B
C
A
A
D
E

V. *Account of a ſpontaneous Inflammation, which happened at Spalding, in Lincolnſhire; communicated to the Editors by a Correſpondent.*

IN the latter end of July, 1794, a bale of candle-wick yarn, made from hemp, in imitation of cotton yarn, was brought to Spalding, from Birmingham; it came by inland navigation to the Trent, was ſhipped at Gainſborough for Boſton, and unloaded there into a Spalding lighter; ſo that it could not have been leſs than a month upon its paſſage.

When examined, it was found to be ſo much ſoaked with oil, reſembling in ſmell rape-oil, that, inſtead of 120 lb. the net weight of the yarn, it weighed 150 lb. or thereabouts; but no probable gueſs could be made of the time when the accident, by which the oil had fallen upon it, happened.

It was placed in a warehouſe at Spalding, where it remained about three weeks; during the whole of which time, a journeyman of the ſhop it be-

longed to, and an apprentice, paſſed every night cloſe to it in their way to bed, but they never obſerved any ſmell iſſuing from it, though they once, duing the latter part of the time, aſſiſted in removing it to ſome diſtance from the place in which it had ſtood.

On Saturday, the 16th of Auguſt, the day after it had been removed, a ſmell of fire was obſerved in the houſe, but it does not ſeem probable that this ſmell iſſued from the bale, as the journeyman and apprentice paſſed it at night as uſual, and on the next night alſo; when, on account of the day being Sunday, the warehouſe had remained ſhut the whole day without any unuſual ſmell being obſerved, though on the Sunday night the journeyman accidentally ſtumbled upon it.

At three o'clock the next morning, however, both were awakened by a ſmoke of a very ſuffocating ſmell; they immediately roſe, and inſtantly ſaw, on opening the warehouſe-door, that the bale was on fire, and glowing; fortunately the warehouſe was above-ſtairs, and the bale lay near the door by which goods are taken in, ſo that it

was

was eaſily thruſt out into the ſtreet, where it inſtantly blazed with ſuch fury as to damage the paint over the door of the houſe near which it lay; it would probably have ſet fire to the wood-work had not water been at hand, with which it was quenched, when four ſtone only of the yarn were conſumed.

VI. *Account of a ſpontaneous Inflammation, which happened in India; by* ISAAC HUMFRIES, *Eſq. in the Service of the Honourable Eaſt India Company.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

ON going into the arſenal a few mornings ſince, I found my friend Mr. Golding, the commiſſary of ſtores, under the greateſt uneaſineſs, in conſequence of an accident which had happened the preceding night. A bottle of linſeed-oil had been left on a table, cloſe to which a cheſt ſtood which contained

contained ſome coarſe cotton cloth; in the courſe of the night the bottle of oil was thrown down, and broken on the cheſt, (by rats moſt probably,) and part of the oil ran into the cheſt, and on the cloth. When the cheſt was opened in the morning, the cloth was found in a very ſtrong degree of heat, and partly reduced to tinder, and the wood of the box diſcoloured, as from burning. After a moſt minute examination, no appearance of any other inflammable ſubſtance could be found, and how the cloth could have been reduced to the condition in which it was found, no one could even conjecture. The idea which occurred, and which made Mr. Golding ſo uneaſy, was that of an attempt to burn the arſenal. Thus matters were when I joined him, and when he told me the ſtory, and ſhewed me the remainder of the cloth. It luckily happened that, in ſome chemical amuſements, I had occaſion to conſult Hopſon's Chemiſtry a very few days before, and met with a paſſage on this particular ſubject, (p. 629,) which I read with a determination to purſue the experiment at ſome future period, but had neglected to do ſo. The moment I ſaw the cloth,

cloth, the fimilarity of circumftances ftruck me fo forcibly that I fent for the book, and fhewed it to Mr. Golding, who agreed with me that it appeared fufficient to account for the accident; however, to convince ourfelves, we took a piece of the fame kind of cloth, wetted it with linfeed-oil, and put it into a box, which was locked and carried to his quarters. In about three hours the box began to fmoke, when, on opening it, the cloth was found exactly in the fame condition as that which had given us fo much uneafinefs in the morning; and, on opening the cloth, and admitting the external air, it burft into fire. This was fufficiently convincing; however, to make it more certain, the experiment was three times tried, and with the fame fuccefs.

VII. *Account of a Chamber Lamp-furnace. By* ROBERT PERCEVAL, *M. D. M. R. I. A.*

WITH A PLATE.

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

THE chamber lamp-furnace, of which a figure is annexed, I have found convenient in many chemical experiments. It conſiſts of a cylindrical body, A. Fig. 1 and 2, (Plate II.) 4$\frac{1}{8}$ inches diameter, and 9$\frac{1}{2}$ high, ſurmounted by a laboratory, (or ſpace for containing veſſels,) which is a hollow truncated cone, B, 6$\frac{1}{2}$ inches wide at top, and 4$\frac{1}{8}$ at bottom. Its conical ſhape adapts it to veſſels of different ſizes. To the inſide of the laboratory are riveted ſix tubes, CCC, $\frac{2}{8}$ths of an inch diameter, on which the veſſel reſts, ſo that ſpace ſufficient for the paſſage of heated air is interpoſed between it and the inſide of the laboratory.

boratory. Into three of thefe tubes iron fpikes (pevioufly fitted to them) are occafionally introduced; two of them are feen in Fig. 1, marked D: their converging extremities form a fupport for veffels, the bottoms of which are lefs than $4\frac{1}{8}$ inches in diameter. In one of thefe tubes, whilft the lamp is burning, is placed the fmall pipe *a*, Fig. 3; which, communicating with the refervoir *b*, fupplies oil gradually to the lamp, through an aperture contrived for that purpofe. The lamp, which is contained in the body of the furnace, is made according to Argand's conftruction, with an oil ciftern, which is a hollow cylinder. The diameter of the wick-holder, in the clear, is one inch and $\frac{5}{8}$; the diameter of the circular air aperture within, E Fig. 2, is one inch $\frac{2}{8}$. The lamp is fupported by two crofs ftays, F F, which are fixed to the top of the tube G. This tube rifes and falls on the ftem H, and is fixed at different heights, by means of the fpring-catch I, which is faftened to the tube, and fits into holes made in the ftem. The tube, in rifing and falling, carries with it the lamp, which, by this means, may be fupported at different

diſtances from the veſſels in the laboratory. The furnace itſelf anſwers the purpoſe of a chimney to the lamp. In the body of the furnace is an opening K, Fig. 1, for trimming the lamp; this may be cloſed by a ſlide. When it is cloſed, the heat of the lamp is conſiderably increaſed, for reaſons too obvious to be inſiſted upon. The bottom of the lamp, to make it more ſteady, is loaded with lead.

I was employed in making ſome experiments with this lamp, aſſiſted by my ingenious friend Mr. Healy, when he ſuggeſted that the heat produced would probably be greater, if the internal air-aperture of the wick-holder were diminiſhed. This conjecture I thought probable, as, in the ſtate of the lamp which I have deſcribed, the central air was ſo far removed from the flame as not to be heated conſiderably by it, and this, we imagined, might counterbalance any advantage which might reſult from the more liberal ſupply of air to the flame. To determine whether this was really the caſe, we cauſed a ſtopper to be made, half an inch in diameter, which, fitting into the central aperture with a ſpring, left a cir-

cular

cular opening $\frac{3}{8}$ of an inch wide for the paſſage of air.

We then obſerved, with a thermometer and ſtop-watch, at what rate mercury contained in a glaſs ſolution bottle, which was placed in the laboratory, acquired temperature; firſt, when the ſtopper was not employed, and, afterwards, when it was. The bottom of the veſſel was one inch and $\frac{7}{8}$ diſtant from the edge of the wick-holder.

The reſult of theſe obſervations is contained in the following table. At the beginning of obſervation, the thermometer placed in the mercury ſtood at 113,5.

Without ſtopper.

Minutes of obſervation.	Temperatures.	Increments of temperature in a minute.
1	143,5	30
2	174	30,5
3	203	20
4	231	28
5	256	25
		142,5 in 5 minutes.

 The

The ſtopper was now put in.

Minutes of obſervation.	Temperatures.	Increments of temperature in a minute.
6	262	36*
7	355	63
8	409,5	54,5
9	458	48,5
10	500	42
		244 in 5 minutes.

It is obvious that the effect of the ſtopper, in increaſing the heat, muſt have been conſiderable; as, from the former part of the obſervation, it appears, that, as the temperature of mercury increaſes, the increments of its temperature, in a given time, (circumſtances remaining the ſame,) diminiſh; yet the ſum of the increments, in the laſt five minutes, conſideraby exceeds the ſum of the increments in the firſt. We now wiſhed to try the effect of diminiſhing ſtill farther the internal air-aperture of the wick-holder; and, for this purpoſe, adapted to the ſtopper a ring, which increaſed its diameter to $\frac{7}{8}$ of an inch, and conſe-

* The increment of temperature in the 6th minute was dimiſhed by lowering the ſlide for the admiſſion of the ſtopper.

quently

quently diminiſhed the width of the circular opening for air to $\frac{3}{16}$ of an inch.

The following table will ſhew the effect of this alteration. In this experiment the lamp burnt leſs briſkly than in the former. The temperature of the mercury at the beginning of obſervation was 113,5.

Without ſtopper.

Minutes of obſervation.	Temperatures.	Increments of temperature in a minute.
1	135	21,5
2	157,5	22,5
3	177	19,5
4	196	19
5	213	17
		99,5 in 5 minutes.
The enlarged ſtopper was now put in.		
6	247	34
7	329	82
8	402,5	73,5
9	468	63,5
10	524	56
		312 in 5 minutes

As the proportion of 311 to 99,5 is much greater than that of 244 to 142,5, the enlarged ſtopper

ftopper appeared to have confiderable advantage in increafing the heat.

The comparative effect of the two ftoppers was determined by another trial, as is expreffed in the following tables.

Lamp with enlarged ftopper.

Temperature of mercury 125.

Minutes of obfervation.	Temperatures.	Increments of temperature in a minute.
1	175	50
2	228	53
3	274	46
		149 in 3 minutes.

Lamp with fmall ftopper.

Temperature of mercury 125.

1	170	45
2	214	44
3	254	40
		129 in 3 minutes.

Thus it appears that, in lamps made on this conftruction, the internal aperture for air may be confiderably diminifhed with advantage. What is the moft advantageous opening, I have not had leifure to determine; but, it is probable that it would not bear to be diminifhed much more than in the experiment laft recited.

VIII.

Fig. 2

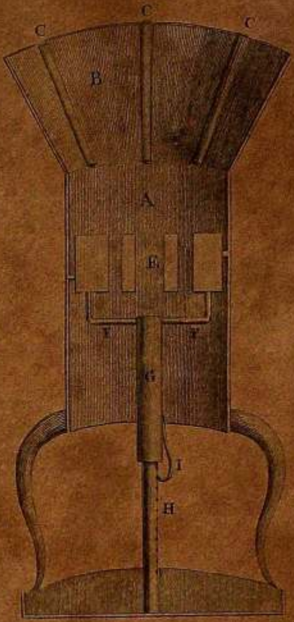


Fig. 1

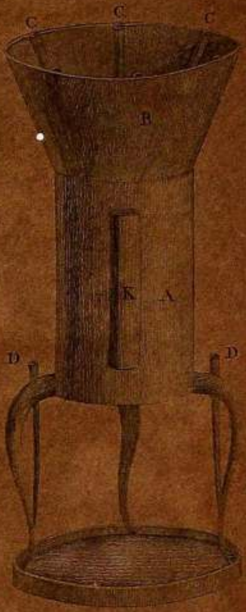


Fig. 3

VIII. *Obſervations on pruning Orchards, in Addition to thoſe already printed* *; *by* THOMAS SKIP DYOT BUCKNALL, *Eſq. of Conduit-ſtreet.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

I HAVE been twice this year to view the orchards at Sittingborne, and now ſend farther obſervations, to throw the huſbandry of orchards under ſuch culture as to preſerve the tree and improve the fruit.

The appearances were much to my ſatisfaction, and I ſaw great reaſon to be pleaſed with the operation of pruning; yet ſeveral of the cherries were much gummed. I examined to ſee whether the gum was from freſh fiſſures, or thoſe formerly medicated; and, to a certainty, the former medica-

* See our firſt volume, p. 25.

tions

tions were perfectly healed; and I did not obſerve, but that the cherry bears the knife very well, with the aid of the medication. I pointed out theſe circumſtances to the tenants, and deſired they would look to them, and open the blotches which had affected the trees ſince pruning.

Mr. R. and J. Boulding informed me, that the medication had been objected to on account of the tar. I ſhould not have thought this of conſequence ſufficient to mention, if it had not been repreſented by William Pattenſon, Eſq. in a paper publiſhed in the XIth volume of the Tranſactions of the Society for the Encouragement of Arts, &c. that to ſmear the ſtems of trees with tar, to keep cattle from biting them, is injurious: certainly, in the ſenſe there conveyed, the obſervation is perfectly right, and, to explain the difference, I muſt beg the indulgence of the Society; for, to ſuffer any doubt to remain, either in the ſcience or practice, would entirely deſtroy the whole ſyſtem.

The

The Formation of Gum.

From the ſtems and leaves of trees, a conſtant and copious evaporation is regularly going on, as may be proved by the air-pump. Now, any ſudden check ſtriking the tree ſtops the pores, and, obſtructing the perſpiration, throws all the ſap into diſorder; which ſoon becoming vitiated, and nature having no other way of relieving itſelf, forces a fiſſure through the bark, out of which oozes the almoſt ſtagnated ſap, which, there condenſing, becomes gum very ſoon; after which, the bark, wanting its due portion of nouriſhment, begins to crack and ſplit: from that time the tree runs faſt into ruin.

Therefore, any ſmearing, or other cauſe which may impede a juſt circulation and perſpiration, muſt injure the tree; but the medication cannot produce any of theſe evils: for, it is applied merely as a plaſter, and is never extended farther than the bare wood or torn bark, and where the gum is oozing through the bark. I deſire to aſſure the Society that, in each of theſe caſes, the medica-

 tion,

tion, from its drying qualities, becomes ſupremely ſalutary, and the wounds heal in half the time they do when expoſed to heat, cold, moiſture, and vermin; for, the misfortune is, being left expoſed, the wounds do not heal; there the evil lies.

Mr. Boulding, in his certificate, ſays, "When "we took off a large branch or two, the wounds "generally cankered; which made us leave them "in the encumbered ſtate they were in rather "than run any hazard."

Mr. Lake alſo remarked, "Many died; others "were wounded by a canker in the bark, from "the bottom of the body to the top arms." Mr. Fauſſet ſays, "I apprized Mr. Bucknall that his "orchards, in the occupation of Meſſrs. Boulding, "were in a very declining ſtate; and in autumn, "1789, having buſineſs with him, I again re- "peated my thoughts relative thereto; and that, "if ſomething was not done to recover the trees, "I ſuſpected that great part, if not all of them, "would certainly die. He (Mr. Bucknall) ſaid "he could eaſily reinſtate the trees, and bring

"them

"them to health, and would come down for that "purpofe, and be anfwerable the trees fhould "not fuftain any injury; and he did come down "in the fpring following."

My agent Mr. Fauffet, the tenants, Mr. Lake, and the Bouldings, all concur in faying that the trees were in an actual ftate of decay. This is a circumftance neceffary to be fully eftablifhed, as any one may fee they did recover, and wonderfully. This induces me to fay that, from the certainty of fuccefs and eafy application, the medication furpaffes any thing for fuch pruning as orchards require. Where trees have been fo long neglected as to become hollow, I would recommend the compofition prepared by Mr. Forfyth, becaufe the hollow parts require a fubftance to fill them up; and I have the happinefs of faying, that Mr. Forfyth and I go on the fame principle; each planning for the general good of fociety, and the improvement of art.

And, as I have long wifhed to introduce the name of orchardift, I here defire it may take

place; and, for the encouragement of thofe who are willing to undertake the art, fay that it is eafily learnt, and highly pleafurable; for, what can be a greater gratification than to fee nature improving under our hands?

It is a miftake to cut off the heads of trees, and engraft them, merely to procure young wood; pruning being better, as an old tree cannot continue in health after fuch loppings; for, the head being gone, the roots become inactive, and more mifchief takes place out of fight than can be repaired in years. Do not attempt to force a tree higher than it is difpofed to grow; for, that will not improve the fruit; the rule fhould be, keep the branches out of the reach of cattle, then let them follow their natural growth; for, each different fpecies of the apple, and other fruits, have a growth peculiar to themfelves. With regard to general pruning, do it as foon as the fruit is off, that the wounds may tend toward healing before the froft comes on; but do not fuffer a broken or decayed branch to continue at any feafon.

If I may make ufe of an exploded idea, the fubftantial form of the tree is the fame before and

after pruning; that is, the tree continues of the ſame ſize, and all the extreme ſhoots keep the ſame diſtance, which is an improvement that no one has brought into practice before; for, each perſon employs his ſtrength to knock the head of the tree to pieces, mutilating it till he leaves the tree in a more decaying ſtate than when he firſt attempted the pruning it. Having ſpoken thus freely, I muſt, in juſtice to the age, ſay there are few profeſſional men who are not expert at wall-fruit pruning; becauſe, it being their profeſſion, they attend to what they are about.

Hints on Planting.

The prevention of a diſeaſe is preferable to the cure; therefore, if poſſible, chooſe the trees the year before they are to be planted, and ſee that they are properly pruned in the nurſery, by taking off, perfectly cloſe, all rambling and unſightly branches, leaving the heads to three or four good leading ſhoots. From this forecaſt the trees will not require pruning for ſome time, and,

having

having no wounds to heal the year they are tranf-planted, will greatly accelerate their growth. Be fure the trees are young; and do not plant any galled, fretted, or cankered, plants.

When the trees are taken up, keep the roots as long as is convenient, which will give them a difpofition to run horizontally; from which, the roots being more under the influence of the Sun, the fap is richer, and produces the fweeteft faireft fruit. Prepare ftakes before the day of planting; for, the trees muft be well ftaked, and defended from cattle; and ufe alfo the other precautions with which planters are well acquainted.

Choofe your ground carefully, that your plan-tation may be fcreened on the Eaft, North, and Weft, fides, and open to the South, and tell the nurfery-man that he muft attend to the natural growth of the different fruits, and mark them, that they may be planted thus: one row of the talleft ftrongeft growers on the three cold fides, and that row fhould be planted twice as thick as any other; then, one more row of the next free-growers, parallel to the laft rows; and fo go on

 gradually,

gradually, declining in fize till you come to the centre.

What I mean by twice as thick is, place a low, rambling, growing, fruit-tree, between each of the others; for, the intention here is to raife fhelter, and it would be advifable, on the outfide of the plantation, to run a row of underwood, more than a pole wide, of the freeft-growing trees which the country produces; be affured the wood will more than pay for the expence. Be not tenacious of the fize or fhape of the orchard; for, in fome fituations, by taking a little more or lefs ground, much good may refult. Before the ground is laid out, let the mind be active to fecure the little rifings, or inflections, to catch the Sun, and exclude the cold. The Scotch fir, or other valuable trees, may be happily introduced at a diftance for fhelter, and would alfo greatly embellifh the appearance of the country.

Such a plantation may be expected often to bear a crop when the whole neighbourhood fails; and every one knows the value of a good crop in a failing year. Thefe ideas are on a large fcale,

for

for the ſupply of the London markets; and, though I can bring no proof that ſuch an orchard exiſts, the hints here given are to point out, that poſition is an eſſential circumſtance, both for the whole plantation and every individual tree; always remembering that local circumſtances muſt govern the buſineſs; follow Nature.

If I have expreſſed this clearly, the orchard will appear, as it were, encloſed on three ſides. The larger trees are to keep off the blighting winds; and, leaving the plantation open in the middle and to the South, is to diſſipate the ſtagnant vapours which ſtunt the fruits in the ſpring; beſides, the ground being open in the middle, the verdure or crop under the trees will be more valuable. This mode of planting will alſo appear handſome, and each tree enjoy the happieſt influence of ſun and air.

The cuſtom of intermixing fruits by chance is always unſightly and detrimental; for, the ſtrong growers conſtantly ſtunt and ſpoil the more delicate fruits, by overtopping them; whereas, by this mode, the delicate fruits fall to the centre and South.

In

In new plantations be careful not to place the trees too deep; more miſchief ariſes from that one ſource than from all other cauſes combined; but, when the trees are too deep, a method may be introduced for raiſing them, or for ſetting them upright when they lean, alſo for making the barren trees fruitful, provided they are in high health, if not, the ſooner they are grubbed up the better. Alſo avoid planting too thick; for, ſunſhine and ſhade are unalterably the cauſes of ſweet and ſour fruits.

I have been careful in expreſſing the manual operations in a plain and ſhort manner, that the practice might appear eaſy. As for the natural and philoſophical accounts of the bark, the formation of gum, the power of vapour, &c. with the relative cauſes of decay in vegetation, I have entered more fully into them, in hopes of inducing gentlemen to take up the practice, and eſtabliſh the profeſſion of an orchardiſt.

Laſtly. I beg the Society not to deem any of theſe circumſtances viſionary; for, I have ſo long dwelt upon the ſubject as to be fully perſuaded of the efficacy of the whole practice, and that it

may be rationally expected, from judicious pruning, that the crooked trees may be made ſtraight, the ſterile fruitful, and the old handſome; as the power of Nature may thereby be regenerated, the diſeaſe removed, all the branches ſupplied with young and bearing wood, ſo that we may almoſt ſay the cauſes of decay are baniſhed; but, to ſupport theſe aſſertions, the trees ought, from their earlieſt infancy, to be in good hands, and root-pruning introduced.

Orchardiſt's Tools recommended by Mr. Bucknall.

Two pruning-knives, a ſaw, two chiſels, a mallet, a ſpoke-ſhave, and a painter's bruſh. With the chiſels and ſpoke-ſhave work upwards, or the bark will ſhiver. The ſaw muſt be coarſe ſet; all the other tools ſharp and ſmooth.

IX. *Obſervations on watering Meadows.*

From the general View of the Agriculture of the County of Wilts; drawn up, for the Conſideration of the Board of Agriculture, by Mr. THOMAS DAVIES, of Longleat, Wilts.

THERE is, perhaps, no part of this kingdom, where the ſyſtem of watering meadows is ſo well underſtood, and carried to ſo great perfection, as in this diſtrict. (South, or, more properly, South-Eaſt, Wiltſhire.) This, which is ſo juſtly called by Mr. Kent the greateſt and moſt valuable of all improvements, was generally introduced into this diſtrict in the latter end of the laſt, and the beginning of this, century. Many of the moſt valuable and beſt-formed meadows, particularly in the Wyley Bourn, were made under the directions of farmer Baverſtock, of Stockton, between the year 1700 and the year 1705. And at preſent there is ſcarcely a river or brook in the diſtrict

 that

that is not applied, in ſome way or other, to this purpoſe.

An imperfect ſcheme of watering had undoubtedly been practiſed before that period. Perhaps, indeed, its introduction into this diſtrict is almoſt co-eval with that of folding ſheep, with which it is intimately connected; but the regular mode, in which both ſyſtems are now conducted, is certainly not very ancient. Many old farmers, who have died within the memory of man, remembered when neither of the ſyſtems were conducted on any regular plan.

Theory of water-meadows. The idea of watering meadows, ſo far as it relates to bring the water upon the land, was taken from nature. It muſt have been always obſerved, that winter floods produced fertility, provided the water did not remain too long on the land. The idea of taking the water off the land at will, and bringing it on again at will, is the effect of art; and the knowledge of the proper time to do this, the effect of obſervation.

A water-meadow is a hot-bed for graſs. In what manner water acts upon land, ſo as to produce

duce a premature vegetation, before natural vegetation begins, is a philoſophical problem, which it is not the province of farmers to ſolve: it was ſufficient for them to know that the fact was ſo. Obſervation on the effect of water, ſo brought on, ſoon ſhewed them at what period its good effects ceaſed, and when it began to do miſchief. This obſervation, therefore, regulated the time of keeping the water on the land; and, as this period was different, on different kinds of land, and at different ſeaſons of the year, it became neceſſary that they ſhould have ſuch a command of the water as to take it off immediately, as ſoon as they found the ſtate of the land required it. This, by degrees, produced that regular diſpoſition of the water-carriages, and water-drains, which, in a well-laid-out meadow, bring on and carry off the water, as ſyſtematically as the arteries and veins do the blood of the human body.

As water-meadows are totally unknown in many parts of the kingdom, and but very partially known in others, it may not be thought improper, in an agricultural account of South Wiltſhire, to ſpeak a little more fully on their nature and properties.

If

If it ſhould tend to excite the ſame improvements in other counties, one of the great objects of the inſtitution of the Board of Agriculture will be anſwered.

Nature and properties of water-meadows. It has been already premiſed, that the principle of a water-meadow is the power of bringing on and carrying off the water at pleaſure; and, provided this great object can be accompliſhed, it is not material what the ſhape of a water-meadow is, or that the diſpoſition of the trenches (provincially, the *works* of the meadow) ſhould be uniform. But, as very little land can be entirely commanded by water, unleſs its inequalities are reduced by manual labour, it has been found convenient to adopt two different kinds of water-meadows; one for land lying on declivities, and which muſt in general be watered from ſprings, or ſmall brooks; and the other, for low land near rivers, to be watered from thoſe rivers.

The firſt kind is called, in Wiltſhire, *catch-work meadows*, and the latter, *flowing meadows*; the latter are by far the moſt general in this diſtrict. It is impoſſible to give any intelligible written de-

ſcription

ſcription of the mode of making theſe meadows; this operation muſt be ſeen, to be properly underſtood.

Catch-work meadows deſcribed. But to elucidate the diſtinction between the two kinds of meadow, and to give ſome idea what are the ſituations in which they may be introduced, it may be neceſſary to remark, that the catch-work meadow * is made by turning a ſpring, or ſmall ſtream, along the ſide of the hill; and thereby watering the land between the new cut, (or, as it is provincially called, the *main carriage*,) and the original water-courſe, which now becomes the main drain. This is ſometimes done, in particular inſtances, merely by making the new cut level, and ſtopping it at the end, ſo that, when it is full, the water may run out at the ſide, and flood the land below it. But, as the water would ſoon ceaſe to run equally for any great length, and would waſh the land out in gutters, it has been found neceſſary to cut ſmall parallel trenches or carriages,

* The catch-work meadows are the kind that is ſo common on the ſides of the hills in Devonſhire.

at

at diſtances of twenty or thirty feet, to catch the water again; and each of theſe, being likewiſe ſtopt at its end, lets the water over its ſide, and diſtributes it, until it is caught by the next; and ſo on, over all the intermediate beds, to the main drain at the bottom of the meadow, which receives the water, and carries it on to water another meadow below, or, if it can be ſo contrived, another part of the ſame meadow, on a lower level.

To draw the water out of theſe parallel trenches or carriages, and lay the intermediate beds dry, a narrow deep drain croſſes them at right angles, at about every nine or ten poles length, and leads from the main carriage at top to the main drain at the bottom of the meadow.

When this meadow is to be watered, the ends of the carriages, adjoining the croſs drains, are ſtopt with turf dug on the ſpot, and the water is thrown over as much of the meadow as it will cover well at a time, which the watermen call a *pitch of work*; and, when it is neceſſary to lay this pitch dry, they take out the turfs, let the water into the drains, and proceed to water another pitch.

This

This kind of water-meadow is ſeldom expenſive; the ſtream of water being uſually ſmall and manageable, few *hatches* are neceſſary; and, the land lying on a declivity, much leſs manual labour is required to throw the water over it regularly, and particularly to get it off again, than in the flowing meadows. The expence of making ſuch a meadow is uſually from three to five pounds *per* acre; the improvement frequently from fifteen ſhillings an acre to at leaſt forty. The annual expence of keeping up the works, and watering the meadow, which is uſually done by the acre, ſeldom ſo high as ſeven ſhillings and ſixpence *per* acre.

Flowing meadows deſcribed. The other kind of water-meadows, viz. thoſe uſually called flowing meadows, require much more labour and ſyſtem in their formation. The land applicable to this purpoſe being frequently a flat moraſs, the firſt object to be conſidered is, how the water is to be got off when once brought on; and, in ſuch ſituations, this can ſeldom be done without throwing up the land in high ridges, with deep drains between them. A main carriage being then taken

 out

out of the river at a higher level, ſo as to command the tops of theſe ridges, the water is carried, by ſmall trenches or carriages, along the top of each ridge; and, by means of movable ſtops of earth, is thrown over on each ſide, and received in the drains below, whence it is collected into a main drain, and carried on to water other meadows, or other parts of the ſame meadow below. One tier of theſe ridges, being uſually watered at once, is commonly called a pitch of work; and it is uſual to make the ridges thirty or forty feet wide, or, if water is abundant, perhaps ſixty feet; and nine or ten poles in length, or longer, according to the ſtrength and plenty of the water.

It is obvious, from this deſcription, that as the water in this kind of meadow is not uſed again and again in one pitch, (as in the catch-work meadows,) this method is only applicable to large ſtreams, or to valleys ſubject to floods, and, as theſe ridges muſt be formed by manual labour, the expence of this kind of meadow muſt neceſſarily exceed the more ſimple method firſt deſcribed; beſides, the hatches that are neceſſary to

manage and temper the water on rivers, muſt be much more expenſive than thoſe on ſmall brooks.

The expence, therefore, of the firſt making ſuch a meadow as this, will be from twelve pounds to twenty pounds *per* acre, according to the difficulty of the ground, and the quantity of hatch-work required; but the improvement in the value of the land, by this operation, is aſtoniſhing. The abſtract value of a good meadow of this kind may fairly be called three pounds *per* acre, but its value, when taken as part of a farm, and particularly of a ſheep-breeding farm, is almoſt beyond computation; and, when ſuch a meadow is once made, it may be ſaid to be made for ever, the whole expence of keeping up the works, and watering it frequently, not exceeding five ſhillings *per* acre yearly; and the expence of the hatches, if well done at firſt, being a mere trifle for a number of years afterwards.

Suppoſed quantity of water-meadows in this diſtrict.

The number of acres of land in this diſtrict, under this kind of management, has been com-

puted, and with a tolerable degree of accuracy, to be between 15 and 20,000 acres. Indeed, it has been found ſo very beneficial, that very few ſpots of land, capable of being watered, remain otherwiſe; unleſs where ſome water-mill ſtands in the way, or where ſome perſon, who has the command of the water above, refuſes to let it be taken out of its natural courſe, to water the lands below.

Some new meadows might be made, and very great and beneficial alterations made in the old ones, if ſome plan could be adopted to get the command of water, where neceſſary, for this purpoſe, and particularly in the caſe of water-mills. A remedy for this will be afterwards propoſed.

Water-meadows do not make a country unhealthy. It has been alleged by thoſe who know very little of water-meadows, that they render the country unwholeſome, by making the water ſtagnant. Daily obſervation proves the fact to be otherwiſe in Wiltſhire; and the reaſon is obvious. It has been already ſaid, that a water-meadow is a hot-bed

bed for graſs ; the action of the water upon the land excites a fermentation ; that fermentation would certainly in time end in putrefaction ; but, the moment putrefaction begins, vegetation ends. Every farmer knows the commencement of this putrefaction, by the ſcum the water leaves on the land ; and, if the water is not then inſtantly taken off, the graſs will rot, and his meadow be ſpoiled for the ſeaſon. The very principle of water-meadows will not permit water to be ſtagnant in a water-mead country ; it muſt be always kept in action to be of any ſervice : beſides, many of the beſt water-meadows were, in their original ſtate, a ſtagnant unwholeſome moraſs. The draining ſuch land, and making it ſo firm that the water may be taken off at will, muſt contribute to the healthineſs of the country, inſtead of injuring it.

Great advantages from water-meadows. It is frequently aſked, how it comes to paſs, that, although water-meadows are ſo uſeful as to be almoſt indiſpenſable in South Wiltſhire, yet in other countries, where they are not known, the want of them is not felt ; nay, that there are, even

in

in this diſtrict, many pariſhes who have none, and even breed lambs without them. To this I anſwer, that the fair queſtion is not, How do other countries do without them? but, How could the farmers of this diſtrict, who are happy enough to have water-meadows, purſue their preſent ſyſtem of ſheep-breeding, if thoſe meadows were taken away? A ſyſtem which, I do not heſitate to ſay, is more profitable to themſelves, their landlords, and the community at large, than any other that could be ſubſtituted in its room; and perhaps this queſtion cannot be anſwered better, than by exhibiting the contraſt between thoſe who have water-meadows, and thoſe who have none, in the ſame diſtrict.

Every farmer who keeps a flock of ſheep, and particularly a breeding flock, in ſo cold and late-ſpringing a diſtrict as South Wilts, knows and feels the conſequences of the month of April. That month between hay and graſs, in which he who has no water-meadows, for his ewes and lambs, frequently has nothing. The ewes will bring a very good lamb with hay only; perhaps

a few

a few turneps are preferved for the lambs, which, in a very favourable feafon, may laft them through March; but, if they are then obliged to go to hay again, the ewes fhrink their milk, the lambs pitch and get ftunted, and the beft fummer-food will not recover them. To prevent this, recourfe is had to feeding the grafs of thofe dry meadows that are intended for hay, the young clovers, and frequently the young wheat, in fact, every thing that is green; and who will pretend to eftimate what is the lofs the farmer fuffers by this expedient?

The ray-grafs, on the expofed parts of this diftrict, is feldom a *bite* for the fheep till near May-day. If the feafon fhould permit any turneps to be kept till that time, (which can feldom be depended upon,) they are not only of little nourifhment to the ftock, but they exhauft the land, fo as to prejudice the fucceeding crop: and it ought to be remarked, by the way, that, in many parts of this diftrict, the foil is not at all favourable to the production of turneps. It therefore neceffarily follows, that a farmer, under thefe circumftances,

cumſtances, has no certain reſource to ſupport his flock, during this month, but hay; and even in that he is ſometimes diſappointed, by having been obliged, in the preceding ſpring, to feed all the land which he had laid up for a hay-crop. He is then obliged to buy hay, and that frequently at the diſtance of many miles; and, to add to his diſtreſs at that critical time, his young ewes are then brought home from wintering, to be kept nearly a month on hay alone.

In this month, which ſo often ruins the crops, and exhauſts the pockets, of thoſe ſheep-breeding farmers who have no water-meadows, the water-mead farmers may be truly ſaid to be in clover. They ſhut up their dry meadows early, ſo as almoſt to inſure a crop of hay; they get their turneps fed off in time to ſow barley, and have the vaſt advantage of a rich fold to manure it. They ſave a month's hay, and have no occaſion to touch their field-graſs till there is a good bite for their ſheep; and their lambs are as forward, by May-day, as thoſe of their leſs lucky neighbours are at Miſummer. And, after all, they are almoſt

moſt certain of a crop of hay on their water-meadows, let the ſeaſon be what it will.

Management of water-meadows. The management of water-meadows, as nearly as it can be deſcribed in an account neceſſarily ſo conciſe as this, is in the following way. As ſoon as the after-graſs is eaten off as bare as can be, the manager of the mead, provincially the *drowner*, begins clearing out the main drain, then the main carriage, and then proceeds to *right up* the works, that is, to make good all the water-carriages that the cattle have trodden down, and open all the drains that they may have trodden in, ſo as to have one tier or pitch of work ready for drowning; which is then put under water, if water is plenty enough, during the time the drowner is righting up the next pitch. In the flowing meadows, this work is, or ought to be, done early enough in the autumn to have the whole made ready to catch, if poſſible, the firſt floods after Michaelmas; the water being then thick and good, being the firſt waſhing of the arable land on the ſides of the chalk-hills, as well as of the dirt from the roads, &c.

The length of this autumn watering cannot always be determined, as it depends on ſituations and circumſtances; but, if water can be commanded in plenty, the rule is, to give it a thorough good ſoaking at firſt, perhaps a fortnight or three weeks, with a dry interval of a day or two; and ſometimes two fortnights, with a dry interval of a week; and then the works are made as dry as poſſible, to encourage the growth of the graſs. This firſt ſoaking is to make the land ſink and pitch cloſe together; a circumſtance of great conſequence, not only to the quantity but to the quality of the graſs, and particularly to encourage the ſhooting of the new roots, which the graſs is continually forming, to ſupport the forced growth above.

While the graſs grows freely, a freſh watering is not wanted; but, as ſoon as it flags, the watering may be repeated for a few days at a time, whenever there is an opportunity of getting water, always keeping theſe fundamental rules in view: *to make the meadows as dry as poſſible between every watering*; and, *to ſtop the water, the moment the*

appearance of any ſcum on the land ſhews that it has already had water enough.

Some meadows, that will bear the water three weeks in October, November, or December, will, perhaps, not bear it a week in February or March, and ſometimes ſcarcely two days in April or May.

In the catch-work meadows watered by ſprings, the great object is, to keep the works of them as dry as poſſible between the intervals of watering; and, as ſuch ſituations are ſeldom affected by floods, and generally have too little water, care is neceſſary to make the moſt of the water, by catching and rouſing it as often as poſſible; and, as the top-works, of every tier or pitch, will be liable to get more of the water than thoſe lower down, care ſhould be taken to give to the latter a longer time, ſo as to make them as equal as poſſible.

Cuſtom of feeding meadows with ſheep. It has already been ſaid, that the great object, in this diſtrict, of an early crop of water-meadow graſs, is to enable the farmer to breed early lambs. As ſoon as the lambs are able to travel with the ewes,

(perhaps about the middle of March,) they begin to feed the water-meadows. Care is, or ought to be, taken to make the meadows as dry as poſſible, for ſome days before the ſheep are let in. The graſs is hurdled out daily in portions, according to what the number of ſheep can eat in a day, to prevent their trampling the reſt; at the ſame time leaving a few open ſpaces in the hurdles, for the lambs to get through, and feed forward in the freſh graſs. One acre of good graſs will be ſufficient for five hundred couples for a day.

On account of the quickneſs of this graſs, it is not uſual to allow the ewes and lambs to go into it with empty bellies, nor before the dew is off in the morning. The hours of feeding are uſually from ten or eleven o'clock in the morning to about four or five in the evening, when the ſheep are driven to fold; the fold being generally at that time of the year, as has been mentioned before, on the barley fallow. And the great object is, to have water-mead graſs, ſufficient for the ewes and lambs, till the barley-ſowing is ended.

Meadows laid up for hay. As ſoon as this firſt crop of graſs is eaten off by the ewes and lambs, the water is immediately thrown over the meadows, (at this time of the year two or three days over each pitch is generally ſufficient,) and it is then made perfectly dry, and laid up for a hay-crop. Six weeks are uſually ſufficient for the growth of the crop, it ſeldom requires eight, and there have been inſtances of great crops being produced in five.

Nature of water-meadow hay. The hay of water-meadows being frequently large and coarſe in its nature, it is neceſſary to cut it young; and, if made well, it then becomes of a peculiarly nouriſhing milky quality, either for ewes or dairy cows.

TO BE CONCLUDED IN OUR NEXT.

X.

X. *Deſcription of a Mill to grind Potatoes; and of the Method of preparing Starch or Flour*, from them; by* M. Baumé.

WITH TWO PLATES.

From the Memoirs of the Academy of Sciences at Paris.

Of all the machines which have been invented for the purpoſe of dividing potatoes, in order to procure flour from them, it is generally acknowledged that a common raſp, or grater, which may be held in one hand, while, with the other, the potatoes are rubbed upon it, is that which dif-

* As the author uſes the words ſtarch or flour *(amidon ou farine)* as ſynonymous, we have done ſo likewiſe; though this paper treats only of the preparation of what is properly called the *ſtarch* of potatoes. We think this remark neceſſary becauſe the word flour, when applied to potatoes, more commonly ſignifies their powder.

poſes

poses the potatoes to give their flour with the greatest ease, and in the greatest quantity. But such an instrument, excellent as it is, on account of the abovementioned properties, furnishes but a tedious and inconvenient means of operating; because the potatoes can be grated only one at a time, and the fingers of those who grate them are very much exposed to be wounded. The advantages obtained by graters, in preparing flour from potatoes, has however led me to the idea of making use of them in the construction of a mill, of which I shall now proceed to give a description.

I had a grater made of plate-iron; it was made in a cylindrical form, (see Plate III. Fig. 1,) about seven inches in diameter, and about eight inches high; the burs made by stamping the holes are on the inside. This grater is supported upon three feet A A A, made of flat iron bars, seven feet high, strongly riveted to the grater; the bottom of each foot is bent horizontally, and has a hole in it which receives a screw, as at A, Fig. 4. A little below the upper end of the three feet

is fixed a crofs piece, B, Fig. 1 and 4, divided into three branches, and riveted to the feet; this crofs piece not only ferves to keep the feet at a proper diftance from each other, and to prevent their bending, but, the centre of it having a hole cut in it, ferves to fupport an axis or fpindle of iron, which I fhall prefently defcribe.

The upper end of this cylindrical grater has a diverging border of iron, C, Fig. 1, 4, and 7, (Plate III. and IV.) about ten inches in diameter at the top, and five inches in height.

Within this cylindrical grater is placed a fecond grater, Fig. 2 and 3, in the form of a cone, the point of which is cut off. The latter is made of thick plate iron, and the burs of the holes are on the outfide; it is fixed, with the broad end at the bottom, as in Fig. 4. At the upper end of the cone is riveted a fmall triangle, or crofs piece of iron, confifting of three branches, D, Fig. 2, in the middle of which is made a fquare hole, to receive an axis or fpindle; to give more refiftance to this part of the cone, it is ftrengthened by means of a cap of iron, E, which is fixed to the

the grater by means of rivets, and has alſo a ſquare hole made in it, to let the axis paſs through.

Fig. 3 repreſents the ſame cone, ſeen in front; the baſe F has alſo a croſs piece of three branches, riveted to a hoop of iron, which is fixed to the inner ſurface of the cone; the centre of this croſs piece has alſo a ſquare hole, for the paſſage of the axis.

Fig. 5 is a ſpindle or axis itſelf; it is a ſquare bar of iron, about ſixteen inches long, and more than half an inch thick, round at the bottom, and alſo towards the top, where it fits into the croſs piece I, Fig. 7, and B, fig. 1 and 4; in theſe pieces it turns round, and by them it is kept in its place. It muſt be ſquare at its upper extremity, that it may have a handle, about nine inches long, fixed to it, by means of which the conical grater is turned round. At G, Fig. 5, a ſmall hole is made through the axis, to receive a pin H, by means of which the conical grater is kept at its proper height within the cylindrical one.

Fig. 6 is a bird's-eye view, in which the mill is repreſented placed in an oval tub, like a bathing-tub. I is the forementioned triangular

iron croſs, fixed with ſcrews to the ſide of the tub; the centre of it has a round hole, for the axis of the mill to move in when it is uſed.

Fig. 7 repreſents the mill in the oval tub, it is placed at one end of it, that the other end may be left free, for any operation to be performed in it which may be neceſſary. A part of the tub is cut off, that the inſide of it, and the manner of fixing the mill, may be ſeen. That the bottom of the tub may not be worn by the ſcrews which paſs through the feet of the mill, a deal board, about an inch thick, and properly ſhaped, is placed under the mill.

When we wiſh to make uſe of this mill, it is to be fixed by the feet, in the manner already deſcribed; it is alſo fixed at the top, by means of the croſs piece I, Fig. 6 and 7. The tub is then to have water poured into it as high as K, and the top of the mill is to be filled with potatoes, waſhed and cut as hereafter deſcribed; the handle L is to be turned round, and the potatoes, after being ground between the two graters, go out gradually at the lower part, being aſſiſted by

the

the motion produced in the water by the action of the mill.

It is not neceſſary, in the conſtruction of ſuch a mill, to be very particular with reſpect to its proportions; but, in order to make known thoſe which experience has taught me to be good ones, a ſcale is given with the figures, to which recourſe may be had. With a mill of this ſize, one hundred pounds of potatoes may be ground in the ſpace of two hours.

Manner of preparing Flour or Starch from Potatoes.

In order to prepare flour or ſtarch from potatoes, any quantity of theſe roots may be taken, and ſoaked in a tub of water for about an hour; they are afterwards to have their fibres and ſhoots taken off, and then to be rubbed with a pretty ſtrong bruſh, that the earth, which is apt to lodge in the inequalities of their ſurface, may be entirely removed; as this is done they are to be waſhed, and thrown into any other tub, full of clean water. When the quantity which we mean to make uſe of has been thus treated, thoſe which are too

large are to be cut into pieces about the fize of eggs, and thrown into the mill; that being already fixed in the oval tub, with the proper quantity of water; the handle is then turned round, and, as the potatoes are grated, they pafs out at the bottom of the mill. The pulp which collects about the mill muft be taken off, from time to time, with a wooden fpoon, and put afide in water.

When all the potatoes are ground, the whole of the pulp is to be collected in a tub, and mixed up with a great quantity of clean water. At the fame time, another tub, very clean, is to be prepared, on the brim of which are to be placed two wooden rails, to fupport a hair-fieve, which muft not be too fine. The pulp and water are to be thrown into the fieve; the flour paffes through with the water, and frefh quantities of water are fucceffively to be poured on the remaining pulp, till the water runs through as clear as it is poured in. The pulp, which is after this left in the fieve, is commonly thrown away as ufelefs; in this manner we are to proceed till all the potatoes which were ground are ufed.

The

The liquor which has paſſed through the ſieve, is turbid, and of a browniſh colour, on account of the extractive matter which is diſſolved in it; it depoſits, in the ſpace of five or ſix hours, the flour which was ſuſpended in it. When all the flour was ſettled to the bottom, the liquor is to be poured off, and thrown away, being uſeleſs; a great quantity of very clean water is then to be poured upon the flour remaining at the bottom of the tub, which is to be ſtirred up in the water, that it may be waſhed, and the whole is to ſtand quiet till the day following. The flour will then be found to have ſettled at the bottom of the tub; the water is again to be poured off as uſeleſs, the flour waſhed in a freſh quantity of pure water, and the mixture paſſed through a ſilk ſieve, pretty fine, which will retain any ſmall quantity of pulp which may have paſſed through the hair-ſieve. The whole muſt once more be ſuffered to ſtand quiet till the flour is intirely ſettled; if the water above it is perfectly clear and colourleſs, the flour has been ſufficiently waſhed; but, if the water has any ſenſible appearance either of colour

or

or of tafte, the flour muft be again wafhed, as it it abfolutely neceffary that none of the extractive matter be fuffered to remain.

When the flour is fufficiently wafhed, it may be taken out of the tub with a wooden fpoon; it is to be placed upon wicker frames covered with paper, and dried, properly defended from duft. When it is thoroughly dry, it is to be paffed through a filk fieve, that, if any clotted lumps fhould have been formed, they may be divided. It is to be kept in glafs veffels, ftopped with paper only.

N.B. Almoft all the flour of potatoes that is to be bought contains a fmall quantity of fand, which is perceived between the teeth; it is owing to the potatoes not having been properly wafhed; for, the fand, which lodges in the knobs and wrinkles of thefe roots, is not always eafy to get out. The operation of cleaning potatoes, although fimple in appearance, requires a great deal of care and attention: the fame obfervation may be made refpecting the care neceffary to procure the flour

of

of a proper degree of whitenefs. It is, when properly made, perfectly white; but, to obtain it in that ftate, it muft be thoroughly feparated, by fufficient wafhing, from all extractive matter. It muft alfo be made in very clean veffels, and in fuch as are not capable of communicating any thing to it. Veffels of earthen or ftone ware would be the moft convenient, but fuch veffels cannot be ufed for operations on a large fcale; we are, therefore, obliged to employ wooden tubs, and we fhould, as much as poffible, make ufe of none but fuch as are made of white wood; oak-wood tubs, or cafks, never fail to communicate to the flour more or lefs colour, unlefs they happen to be exhaufted of their extractive matter, by having been frequently, and for a long fpace of time, kept full of water.

As the mill is plunged into water, while it is ufed, it is not much difpofed to be clogged; it is, however, proper to remove, from time to time, the mafs of ground potatoes which is collected under it. We may, if we chufe it, wafh the pulp as foon as it is ground; for this purpofe, we muft put it into the hair fieve, as it comes

from the mill, and pour a ſufficient quantity of water upon it to ſeparate the flour from it. What remains in the ſieve is the fleſhy pulp of the root, deprived of the ſediment already ſpoken of. This pulp is very nouriſhing; it may be boiled in water, and uſed as food for animals. The manner of employing it is an object which deſerves ſome conſideration, particularly when potatoe-flour is made in large quantities, as what remains in the ſieve is about ſeven-eighths of the whole quantity, which is too much to loſe.

The firſt ſeparation of the pulp, which is made by means of the hair-ſieve, is very convenient, as by it we quickly get rid of a great quantity of pulp; if a little of it ſhould paſs through the ſieve, it ſettles after the flour, conſequently falls on the ſurface of it, and gives it a dirty colour; but that is of no conſequence, for, as it is more groſs than the flour, it is eaſily ſeparated from it by the ſilk ſieve, of which we have already ſpoken.

Fig. 1.

Fig. 2.

Fig. 5.

Fig. 4.

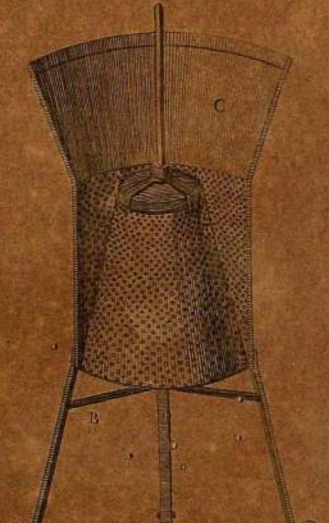


Fig. 3.

Fig. 6

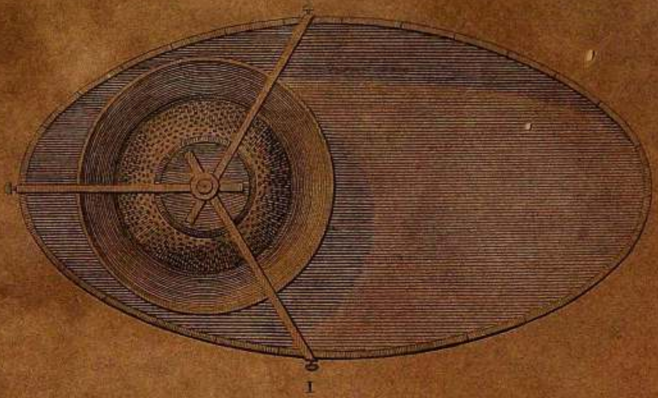
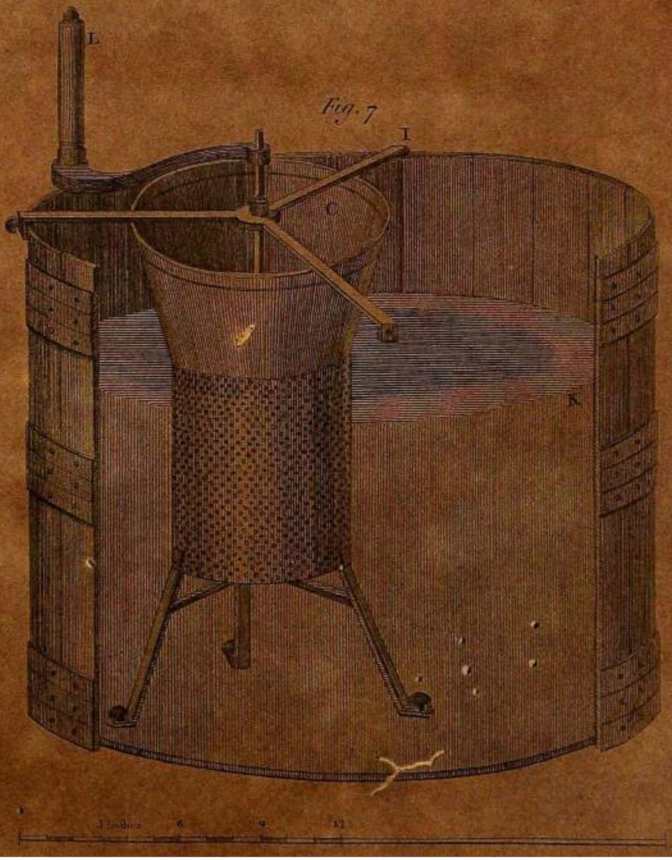


Fig. 7



REPERTORY
OF
ARTS AND MANUFACTURES.
NUMBER XIV.

PRINTED BY JOHN NICHOLS, RED LION-PASSAGE, FLEET-STREET.

XI. *Specification of the Patent granted to Mr.* FRANCIS BLAIKIE, *of Glaſgow, in the Kingdom of Scotland, Merchant; for the Invention (diſcovered to him) of an Ingredient to be uſed as a Subſtitute for Gum, in thickening of Colours for printing, which will anſwer all the Purpoſes of that Article, at a much more reaſonable Rate.*

Dated June 11, 1788.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid priviſo, I the ſaid Francis Blaikie do hereby declare, that the ſaid invention is deſcribed in manner hereinafter mentioned; that is to ſay, the gum ſubſtitute, to thicken colours for linen and calico

 printing,

printing, and making up or furniſhing printers colour-tubs, and which may alſo be applied to ſeveral other uſes, is prepared by boiling any quantity of flax-ſeed in a ſufficient quantity of water, until the whole ſubſtance be extracted thereby; and, having ſtrained it through a linen or woollen cloth, again boil down the liquor to the conſiſtence of a jelly. Put it into a cloſe veſſel, and, for preſervation, put in a little ſtrong ſpirits, or pour a little ſweet-oil on the top of it; bitters may alſo be uſed to preſerve it. In uſing the ſubſtitute, the printer may either put a certain quantity into a gallon of colour, according to the nature of it, and the particular kind of work to be done, and regulate himſelf by trial, as is common in uſing gum; or reduce the ſubſtitute, by boiling in water to the conſiſtence wanted. In witneſs whereof, &c.

XII. *Specification of the Patent granted to the Right Honourable* Henry Seymour Conway, *for his Method of adapting or conveying the Heat arising from the Fire of Coal employed in Coke-ovens, for working Steam-engines, baking Bread, &c. calcining and fusing Ores and Metals; also for warming Rooms, &c. heating Water for Baths and for many other useful Purposes; by which Means the Expence of the Coal, or other Fuel, which hath hitherto been necessary for the above Operations, is intirely, or in the greatest Part, saved.*

Dated June 23, 1789.

TO all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Henry Seymour Conway do hereby declare, that my said invention is described in manner following; that is to say, in the variety of cases in which the above invention and improvement may be employed, according to the different purposes and situations, it would be impossible to describe them so minutely as to admit

of no variations; but the general principle being adhered to, it will be ſufficient to furniſh ſuch a deſcription as may make the utility and practicability of them, for the different purpoſes, or the moſt material ones to which they may be applied, clearly underſtood. 1ſt. In working ſteam-engines, the coal being ſpread on a flat or dead hearth, as is uſual in coke-ovens, and being ſurrounded and covered over with an arch or crown of brick-work, formed ſo as well to contain and reverberate the heat, the proper openings muſt be made or left in the crown, or the ſearch, through which to convey the flame and heat of the coal, while it is burning to be charred or made into coke, ſo as to give heat to the boiler employed, ſufficient to raiſe the ſteam neceſſary for working the engine to which it is to be adapted, according to the ſize of its cylinder, and force required; and to this the ſize of the oven, as well as the flues or openings, muſt be adapted. Theſe openings may be of different forms, having the neceſſary number of ſquare inches as a vent for the flame and heat; and may be variouſly placed, according to the poſition and form of the boiler; but, by different ex-

experiences and trials, are thought generally beſt when made in the backward part of the oven, the draught being apparently briſker, and the flame, being conveyed under the bottom of the boiler, in ſuch a ſteam or body as may give the neceſſary heat, ſhould be drawn round the boiler in one or more flues, according to the ſhape of the boiler, and height of water. Where the latter is not conſiderable, it may be ſufficient to fill the ſpace under the boiler with flame, and then carry it off to the chimney, or direct it to any other purpoſe, taking care that the flues or openings from under the boiler be ſo framed as not to carry off the flame by too quick a draught; which, beſides a due ſize given to ſuch flues, ſhould be farther governed by regiſters placed therein, ſo as to check the draught at pleaſure; by that means, either keeping a full body of flame under the boiler, or increaſing its activity by a briſker draught, which may be varied according to the different ſtates of the fire. When the heat is to be given to ovens, for the purpoſe of baking bread or biſcuit, or for pies or meat, or any other kind of things to be dreſſed or baked in ovens, the flame or heat muſt then be

conducted

conducted ſo as to heat all parts of the ſaid baking-ovens, whether placed over the coke-ovens, or in the back, or in any other direction ſufficiently contiguous. For this purpoſe, flues are to be formed under the bottom of the baking-ovens, in ſuch manner as to diſperſe the heat, as near as may be, equally to the different parts; carrying it from the bottom, by a circular flue each way, round the ſearch or ſides, whence it riſes to give heat in the ſame way over the top; making the brick-work, in each part, of a thickneſs calculated to give the requiſite warmth without burning; for which end it ſhould be made ſomewhat thickeſt under the bottom, where it comes firſt from the coke-oven, and thinneſt over the crown, where it may have loſt ſomething of its force. An oven or machine for baking buiſcuit on this plan has been erected and worked, by which three baking-ovens are heated from the fire of the ſame coke-oven; one of them being placed immediately over, and the two others behind, the ſame coke-oven, on a level with it, and as near as they could ſtand to each other, at equal diſtance from it. The flame for heating the two laſt iſſuing from the

back

back of the coke-oven, and that for the firſt riſing by flues or openings through the crown; all the ſaid openings from the coke-oven being governed by regiſters between the coke and baking ovens, ſo as that the flame may be ſhut off from any or all of them at pleaſure; to which are alſo added other regiſters in the chimney-flues, to damp or check the heat, and detain it more or leſs in its circulation round the ſeveral baking-ovens reſpectively. The baking ovens may alſo be heated by the admiſſion of the flame from the coke-oven into them, through a large opening, for as long time as may be neceſſary to give the proper heat. The mouth may, at the ſame time, be cloſed, and only a ſmaller opening or flue left, ſufficient to carry off the flame, and to keep the body of the oven full, as in reverberating-furnaces. Thoſe ſmall openings may alſo be governed by regiſters; it ſhould, however, be obſerved, not to admit the flame till the fire in the coke-oven is become clear; the ſaid opening from the coke-oven being afterwards cloſed by a regiſter, the heat will then remain equal, or diminiſh gradually, as in the common way of heating

ovens

ovens by faggots, &c.; and in this manner two, or more, baking-ovens may be heated alternately from the ſame coke-oven, and the proceſs continually repeated. When metals are to be calcined, or melted, a furnace adapted to thoſe purpoſes is placed contiguous to the coke-oven, whence the flame ſhould be conveyed immediately through large openings, and in as full a body as may be, with this caution, that, in melting, the fire ſhould not be ſuffered to paſs into the furnace (being ſhut off by regiſters) till the ſulphur and ſmoke of the coals is paſt off, and the flame appears bright and clear; in all caſes the chimney ſhould be raiſed to a conſiderable height, as of thirty or forty feet, or more, as is common for furnaces, in order to command a quick draught, which may be conſtantly reſtrained by the regiſters, as above deſcribed. This invention has (as may appear in part from what has been ſaid) the peculiar property and advantage that the ſame oven may, at the ſame time, be applied to ſeveral different purpoſes; or that two, or more, coke-ovens may be ſo placed as to be applicable to one and the ſame purpoſe, as in the caſe of ſteam-engines, or of

ſome

ſome metallic proceſſes, where a great force of fire is required; and, in ſteam-engines, the ſteam may be acquired either from two, or more, different boilers, or the heat from the different coke-ovens applied to ſingle boilers of an extraordinary dimenſion; and at all ſuch forges where the price of coal is any way conſiderable, and the demand of coke great, this method ſeems to offer the higheſt advantage. Another particular in theſe conſtructions, of ſingular advantage in many caſes, is the readineſs with which they may be made to turn off the fire, and to cool; for, in thoſe, not only double regiſters may be uſed immediately to ſhut off the flame, but alſo air-holes placed between thoſe regiſters, to be opened like them at pleaſure, as well as other air-holes alſo, to open between the crown of the coke-oven and bottom of the boiler, or into the circular flues, if deſired; which will prodigiouſly quicken the cooling, and which, being afterwards ſtopt with bricks or plugs, well adapted and luted where neceſſary, will render the alternate admiſſion and excluſion of the air complete: and will have the farther advantage of making openings to clear the

 different

different flues occaſionally. When the purpoſe to be ſerved is that of warming houſes, or ſtaircaſes, the oven may either be placed in ſome convenient ſpot joining to the wall of the houſe, and the flame or heat drawn from it into flues within, properly diſpoſed to receive and conduct it; or the body of the oven may be placed within the houſe, covered as ſtoves often are, in ſuch manner for convenience or appearance as may be thought beſt; which may be more eaſily done, as coke-ovens of a moderate, or even ſmall, ſize are found to give heat ſo as to produce very conſiderable effects. The heat or flame, being conducted through the flues, as before mentioned, to the places to be warmed or heated, may be uſed for different domeſtic or other purpoſes. An oven of this kind, of no more than three feet diameter, and one foot and a half in the height, or little more, having been experienced to keep a boiler, containing ſeventy-two gallons of water, conſtantly boiling, ſo as to evaporate nine gallons *per* hour, and to work, at the ſame time, a ſmall ſtill; and ſometimes to calcine, or melt, both copper and iron. It may be uſeful to mention, that regiſters much

expoſed

expofed to the immediate heat of the fire fhould be made of the beft ftourbridge, or other ftrong loam, or brick earth, or of a compofition of fuch loam and old burnt ware from glafs-houfes, &c. pounded, or other like compofition; in other parts they may be conveniently made of iron, of different thicknefs, according to the different diftances from the fire. It has alfo been found ufeful, where the heat is very great, to have the iron handles, ufed for drawing the loam or compofition regifters, fo fixed, by hold-fafts in holes made in the regifters for that purpofe, that no part may be expofed to the great impulfe of the fire, but defended by the brick-work. It may alfo be found ufeful, when the regifters are of extraordinary fize, to make them a little of a wedge form, narrowing towards the end, in order to their drawing or lifting with eafe; the grooves in which they run being made in the fame form, fo as to fhut well when clofed. In witnefs whereof, &c.

XIII. *Specification of the Patent granted to* EDMUND CARTWRIGHT, *of Doncaſter, in the County of York, Maſter of Arts, Clerk; for his Invention of a new Principle, on which Bricks, Stones, or any other Building-Materials which may be ſubſtituted for thoſe Articles, may be ſo formed as to be applied with peculiar Advantage in the Erection of Walls, and in the Conſtruction of Arches.*

WITH TWO PLATES.

Dated April 14, 1795.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Edmund Cartwright do hereby declare, that my invention conſiſts in giving bricks, ſtones, or any other building-materials which may be ſubſtituted for thoſe articles, ſuch a ſhape or form as that, when in work, they ſhall mutually lock into or cramp each other. The principle of this invention will readily be comprehended and underſtood, by ſuppoſing the two oppoſite

ſides

ſides of a common brick to have a groove or rabbet down the middle, which groove or rabbet muſt be a little more than half the width of the ſide of the brick in which it is made; there will then be left a ſhoulder on each ſide of the groove or rabbet, each of which ſhoulders will be nearly equal to one quarter of the width of the ſide of the brick, or to one half of the groove or rabbet. (See Plate V. Fig. 1.) A courſe of theſe bricks being laid ſhoulder to ſhoulder, as in Fig. 5, (Plate VI.) they will form an indented line, of nearly equal diviſions; the grooves or rabbets being ſomewhat wider than the two adjoining ſhoulders, to allow for mortar, &c. When the next courſe comes on, the ſhoulders of the bricks which compoſe it will fall into the grooves or rabbets of the firſt courſe; and the ſhoulders of the firſt courſe will fit into the grooves or rabbets of the ſecond; and ſo on. (See Fig. 1 and 5.) This mode of ſhaping the bricks, &c. as being perfectly ſimple, I prefer; the principle, however, will be preſerved, in whatever manner they may be made to lock into or cramp

each

each other, by whatever form of indenture, or whether by one groove, or rabbet, or more. But it muſt be obſerved, in whatever manner the variation from the ſimple form Fig. 1. is made, except by ſtreight lines, the two ſides of the brick, &c. muſt proportionally vary, ſo that, when they come together in work, they may correſpond and fit each other; an exemple of which is exhibited in Fig. 2, where A and B ſhew the oppoſite ſides of a brick. It may make ſome ſmall ſaving in the expence, though perhaps not a prudent one, if the bricks, &c. were of ſuch a width as to admit a common brick, or piece of plain ſtone, &c. between the ſhoulders of each of theſe bricks, &c. in that caſe, the groove or rabbet muſt be made proportionably wider. For the purpoſe of turning the angles, it may be expedient to have bricks or ſtones of ſuch ſize and ſhape as to correſpond with each wall reſpectively; this, however, is not abſolutely neceſſary, as the groove or rabbet in the bricks, &c. of each wall, where they croſs or meet each other, may be levelled, and the bricks, &c. lap over, as in the common mode.

mode. For the purpoſe of breaking the joints in the depth of the walls, bricks, &c. will be re- quired of different lengths, though of the ſame width. Buildings conſtructed with bricks, &c. of this principle, will require no bond-timber, one univerſal bond running through, and con- necting, the whole building together; the walls of which can neither crack, nor bulge out, without breaking through the bricks, &c. themſelves. When theſe bricks, &c. that is to ſay, of the ſimple form, Fig. 1, are uſed for the conſtruction of arches, the ſides of the grooves or rabbets, and the ſhoul- ders, ſhould be the radii of the circle, of which the intended arch is to be a ſegment. See Fig. 3. Though, if the circle be very large, the differ- ence of the width of the bricks, &c. at top and bottom, will be ſo trifling as to make a minute attention to this particular ſcarcely, if at all, ne- ceſſary. When theſe arches are required to be particularly flat, or are applied in ſuch ſituations as admit not of end-walls, as in the conſtruction of bridges, &c. it may be expedient to have the ſhoulders dovetailed, to prevent the arch cracking

acroſs,

acroſs, or giving way endwiſe. See Fig. 4. If the bricks are as wide at the bottom as the top, the manner of putting them together by a dovetail is obvious; when not ſo wide at the bottom as the top, on one ſide of the brick, &c. the ſides of the ſhoulders muſt be parallel, and on the other the ſides of the grooves or rabbets muſt be parallel, ſo that the two ſides of the bricks, &c. which fall together, may correſpond. See Fig. 4, B, C. In forming an arch, the bricks, &c. muſt be courſed acroſs the centre on which the arch is turned, and a grooved ſide of the bricks, &c. muſt face the workman. See Fig. 6. It may be expedient, though not abſolutely neceſſary, in laying the firſt two or three courſes at leaſt, to begin at the crown, and work downwards each way. In arch-work, the bricks, &c. may be either laid in mortar, or dry, and the interſtices afterwards filled, and wedged up, by pouring in lime-putty, plaſter of Paris, grouting, or any other convenient material, at the diſcretion of the workman or builder. It is obvious that arches upon this principle, having no lateral preſſure, can neither expand at the

the foot, nor ſpring at the crown, conſequently they will want no abutments, requiring only perpendicular walls to be let into, or to reſt upon; and they will want no incumbent weight upon the crown to prevent their ſpringing up, a circumſtance of great importance in many ſituations in the conſtruction of bridges. Another advantage attending this mode of arching is, that the centres may be ſtruck immediately; ſo that the ſame centre, (which in no caſe need be many feet wide, whatever may be the breadth of the arch,) may be regularly ſhifted, as the work proceeds. But the greateſt and moſt ſtriking advantage attending this invention is, the abſolute ſecurity it affords (and at a very reaſonable rate) againſt the poſſibility of fire; for, from the peculiar properties of this arch, requiring no abutments, it may be laid upon, or let into, common walls no ſtronger than what are required for timbers, of which it will preclude the neceſſity, and ſave the expence. In witneſs whereof, &c.

Explanation of the Figures referred to in the above Specification.

(See Plate V. and VI.)

Fig. 1. A, the ſide of the brick; B, the plan.

Fig. 2. A brick in which the two ſides A and B vary, that when they come together in work they may correſpond and fit each other.

Fig. 3. The ſide of a brick, the ſides of whoſe ſhoulders are radii of a circle.

Fig. 4. Dovetailed bricks. A, the bricks as they appear in work endwiſe. B and C, the two ſides of the dovetailed bricks, when wider at the top than bottom.

Fig. 5. ſhews the face of an upright wall, and alſo the appearance of the bricks, &c. both on the upper and under ſide of an arch.

Fig. 6. An arch as it faces the workman.

XIV.

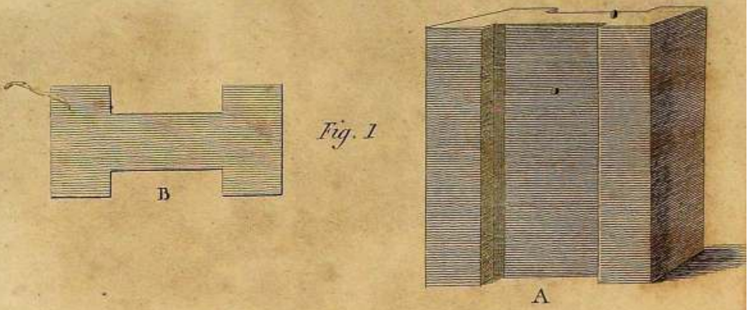


Fig. 1

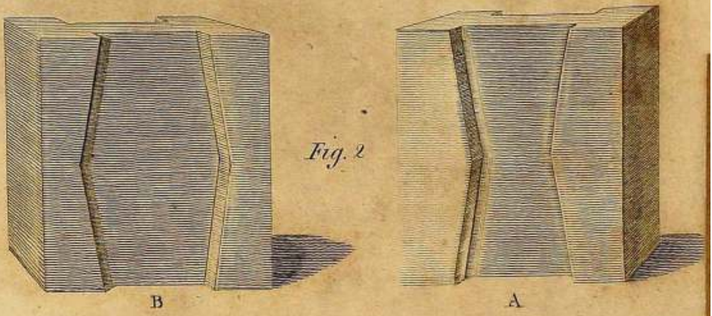


Fig. 2

Fig. 3

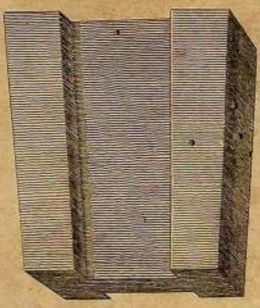


Fig. 4

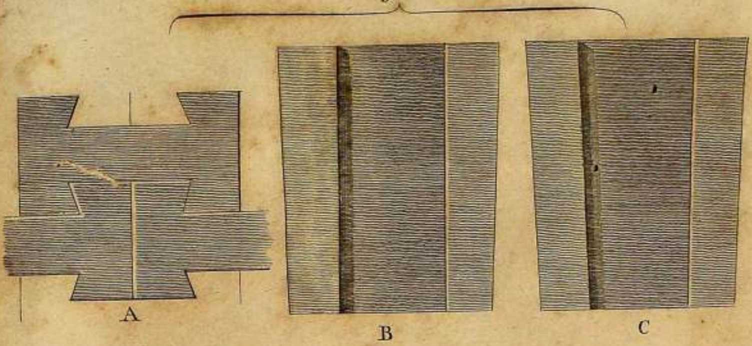


Fig. 5

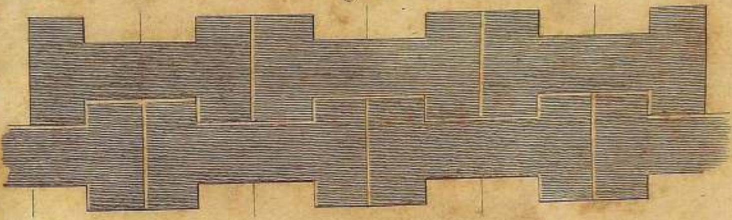
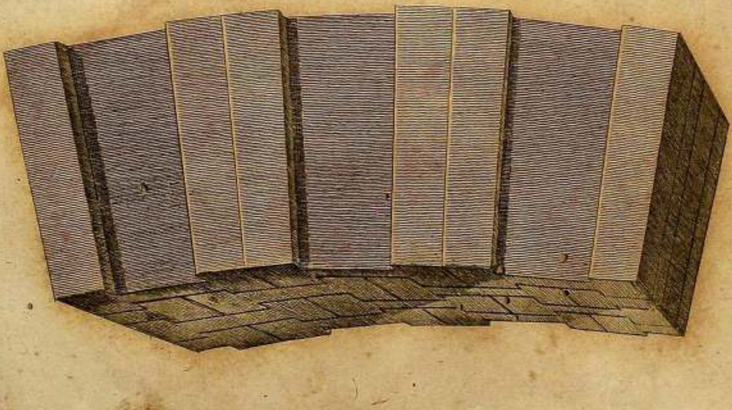


Fig. 6



REFOGI'S SARASWATI MAHAL LIBRARY

XIV. *Farther Considerations on the Pangraph; in a Letter to the Editors, from* THOMAS NORTHMORE, *Esq. of Queen-ſtreet, May-Fair.*

AT the time that I committed to paper my former thoughts upon the ſubject of the Pangraph, or univerſal character, I was not ſufficiently aware of the facility with which it might be *ſpoken*, and thus become, at leaſt as far as regards the common concerns of life, *an univerſal language.*

It certainly appears at firſt ſight extraordinary, but I truſt will be found ſtrictly true, that, to the attainment of ſo deſirable an end, about *thirty* or *forty* diſtinct ſyllables, nay, according to one method, *eleven* only, are requiſite.

Firſt then, I beg leave to propoſe, that the ten numerals be accurately diſtinguiſhed by ten ſimple names: theſe I would recommend to be monoſyllables, eaſy of pronunciation in *all* languages, and, if poſſible, to run without difficulty into one another. For the preſent I will call them by the common Engliſh terms; though undoubtedly, if

 imaginary

imaginary appellations are not to be preferred, the French language would anſwer better than our own, as being better underſtood.

Secondly, I would pronounce each numeral by its component parts, after the manner of accomptants. *Ex. gr.* Let the number 6943 repreſent the word *horſe:* I would not ſay, *ſix thouſand nine hundred and forty-three*, but, with much greater ſimplicity, *ſix*, *nine*, *four*, *three*, and ſo on for all the words of a ſentence, making the proper ſtop between each.

Thirdly, In the ſame manner, to each of the *prefixed ſigns* * a diſtinct appellation muſt be appropriated, to be pronounced immediately after the numeral to which it is an appendage. *Ex. gr.* Let *Plu* be the appellation, or the ſign, of the plural number; *ſix, nine, four, three, Plu*, would become *horſes.*

Thus, I hope, it is evident that about 30 or 40 diſtinct ſyllables are ſufficient for the above purpoſe; but I am much miſtaken if *eleven* only will not anſwer the ſame end. This is to be done by ſubſtituting the firſt 20 or 30 numerals for the

* See our ſecond volume, p. 309.

ſigns,

ſigns, and ſaying, as in Algebra, that a term is in the power of ſuch a number, which may be expreſſed by the ſimple word *under*. *Ex. gr.* Let 6943 repreſent the word *horſe*; and, ſuppoſe 4 to be the ſign of the plural number, I would write the word thus $\frac{4}{6943}$; and pronounce it, ſix, nine, four, three, in the power of, or *under*, four. By theſe means eleven diſtinct appellations would be ſufficient, and time and uſe would much abbreviate the pronunciation.

I do not think it neceſſary to enlarge any farther upon this ſubject, as it appears to me that the beſt method of bringing any matter of this ſort to perfection, is to lay it before a company of literary men. I cannot however in juſtice conclude without obſerving that, ſome little time after the publication of the Pangraph, on reading the Encyclopædia Britannica, article *Character*, Vol. IV. p. 337, I met with an extract from the *Journal Littéraire*, Anno 1720, the author of which had propoſed the Arabic or numeral figures for univerſal characters. "The combination of "theſe nine (he obſerves) are ſufficient to ex- "preſs diſtinctly an incredible quantity of num-

"bers,

"bers, much more than we fhall need terms to "fignify our actions, goods, evils, duties, paf-"fions, &c." From which, and what follows, it appears that he meant, in the fame extenfive fenfe as Bifhop Wilkins and Leibnitz, that his characters fhould, in an unlimited degree, and without any intermediate affiftance, reprefent *things*; and confequently the difficulty of attaining them, notwithftanding the univerfality of the character itfelf, is not much, if at all, diminifhed. With refpect to the pronunciation of his characters, he totally lays it afide, obferving that, "in the cha-"racters here propofed, this difficulty has no "place; every nation is to pronounce them ac-"cording to the particular pronunciation that al-"ready obtains among them."

I can only fay that I have thought it right to mention this circumftance, as, if your readers fhall fo determine, I am very willing to forego the claim of originality, provided I can contribute in the leaft either to their amufement or their advantage. I am, &c.

T. NORTHMORE.

XV.

XV. *Obſervations on Spontaneous Inflammations; with a particular Account of that which happened on-board a Ruſſian Frigate in the Year* 1781; *and of the Experiments made in order to aſcertain the Cauſe of it. In a Letter to the Editors, from the Reverend* William Tooke, *F. R. S. Member of the Imperial Academy of Sciences at St. Peterſburgh, &c.*

THE following obſervations on ſpontaneous inflammations were drawn up, a few years ago, in Ruſſia; they were ſuggeſted by an accident which happened on-board a frigate lying in the harbour of Cronſtadt, of which mention is made in your laſt number *. I was then at Cronſtadt, and conſequently had an opportunity of procuring an accurate account, not only of the accident itſelf, but alſo of the experiments made to aſcertain the cauſe of it. If you think proper to add them to the accounts of ſpontaneous inflammations which you have already publiſhed, you are at liberty to do ſo.

* See our ſecond volume, page 425.

The

The explication of the causes of spontaneous inflammations, in certain substances and compositions, must ever be an object of consequence to the magistracy; as, by discovering the causes of such phænomena, the suspicion of felonious practices in setting fire to buildings may frequently be avoided, and many an innocent person saved from capital punishment. A bare attempt to lessen the number of victims, that may possibly be doomed to bleed at the bar of mistaken justice, can never be thought either frivolous or impertinent.

I intentionally pass over the *pyrophori*, at present so well known to chymists, prepared from alum, &c. as not properly belonging to my design, though deserving of notice in explaining the causes of spontaneous inflammation; nor shall I say any thing of those inflammations that happen in the mineral kingdom, in coal-mines, alum-pits, &c. as they are already sufficiently known, and their causes have often been discussed.

Of incomparably more importance, and far less known, are the spontaneous inflammations of substances from the animal and vegetable kingdoms; and these are what I design here briefly to bring together: as I firmly believe, that a more extensive

ſive publication of theſe phænomena may prove of general utility to mankind, by leſſening the dangers to which they are expoſed.

A recent inſtance will ſerve to elucidate what I now advance. A perſon of the name of Rüde, at that time an apothecary at Bautzen, had prepared a *pyrophorus* from rye-bran and alum. Not long after he had made the diſcovery, there broke out, in the next village of Nauſlitz, a great fire, which did much miſchief, and was ſaid to have been occaſioned by the treating of a ſick cow in the cow-houſe. Mr. Rüde knew that the countrymen were uſed to lay an application of parched rye-bran to their cattle, for curing the thick neck; he knew alſo, that alum and rye-bran, by a proper proceſs, yielded a *pyrophorus*; and now he wiſhed to try whether parched rye-bran alone would have the ſame effect. Accordingly, he roaſted a quantity of rye-bran by the fire, till it had acquired the colour of roaſted coffee. This roaſted bran he wrapped up in a linen cloth; in the ſpace of a few minutes there aroſe a ſtrong ſmoke through the cloth, accompanied by a ſmell of burning. Not long afterwards the rag grew as black as tinder, and the bran, now become hot,

 fell

fell through it on the ground in little balls. Mr. Rüde repeated the experiment at various times, and always with the same result. Who now will any longer doubt, that the frequency of fires in cow-houses, which, in those parts, are mostly wooden buildings, may not be occasioned by this common practice, of binding roasted bran about the necks of the cattle? The fire, after consuming the cattle and the shed, communicates itself to the adjoining buildings; great damage ensues; and the ignorant look for the cause in wilful and malicious firing, consequently in a capital crime.

Montet relates, in the *Mémoires de l'Académie de Paris*, 1748, that animal substances, under certain circumstances, may kindle into flame; and that he himself has been witness to the spontaneous accension of dunghills. The woollen stuff prepared at Sevennes, which bears the name of Emperor's-stuff, has kindled of itself, and burnt to a coal. It is not unusual for this to happen to woollen stuffs, when in hot summers they are laid in a heap, in a room but little aired.

In June, 1781, the same thing happened at a wool-comber's, in a manufacturing town in Germany,

many, where a heap of wool-combings, piled up in a close warehouse seldom aired, took fire of itself. This wool had been by little and little brought into the warehouse; and, for want of room, piled up very high, and trodden down, that more might be added to it. That this combed wool, to which, as is well-known, rape-oil mixed with butter is used in the combing, burnt of itself, was sworn by several witnesses. One of them affirmed that, ten years before, a similar fire happened among the flocks of wool at a clothier's, who had put them into a cask, where they were rammed hard, for their easier conveyance. This wool burnt from within outwards, and became quite a coal; it was very certain that neither fire nor light had been used at the packing, consequently the above fires arose from similar causes.

In like manner very credible cloth-workers have certified, that, after they have bought wool that was become wet, and packed it close in their warehouse, this wool has burnt of itself; and very serious consequences might have followed, if it had not been discovered in time.

The ſpontaneous accenſion of various matters from the vegetable kingdom, as wet hay, corn, and madder, and at times wet meal and malt, are already ſufficiently known. Experiments have likewiſe repeatedly been made with regard to ſuch phænomena; and it will preſently appear, that hemp, or flax, and hemp-oil, have frequently given riſe to dreadful conflagrations. Montet ſays: In the year 1757, a ſort of ſailcloth, called *pre-lart*, having one ſide of it ſmeared with ochre and oil, took fire in the magazine at Breſt, where it had probably kindled of itſelf. It is not at all unlikely that many fires in ſea-ports have ariſen from theſe ſelf-accenſions; as it has often happened that, after the ſtricteſt inquiry, the real cauſe of them has not been diſcovered.

About twenty years ago, ſeveral fires broke out within a ſhort ſpace of time in a rope-walk, and in ſome wooden houſes, at St. Peterſburgh; and, in all theſe inſtances, not the ſlighteſt trace of wilful firing could be found; but there was lying in the rope-walk, where the cables for the navy are made, a great heap of hemp, among which a conſiderable quantity of oil had been careleſſly ſpilt,

spilt, and it was therefore declared spoilt; for which reason it had been bought at a low price, and put up together, and was held to be the cause of the fire. The inferior inhabitants of that part of the town had likewise bought of this spoilt hemp, at a cheaper rate than usual, for closing the chinks, and caulking the windows of their houses, which are constructed of balks laid one upon the other. At this rope-walk, coils of cable have been found hot, and the people have been obliged to separate them, to prevent farther danger.

It was in the spring of the year 1780, that a fire was discovered on-board a frigate lying in the road of Cronstadt; which, if it had not been timely extinguished, would have endangered the whole fleet. After the severest scrutiny, no cause of the fire was to be found; and the matter was forced to remain without explanation, but with strong surmises of some wicked incendiary being at the bottom of it. In the month of August, in the same year, a fire broke out at the hemp-magazine at St. Petersburgh, by which several hundred thousand poods * of hemp and flax

* A pood consists of 40 pounds Russ, or 36 pounds English.

were

were consumed. The walls of the magazine are of brick, the floors of stone, and the rafters and covering of iron; it stands alone on an island in the Neva, on which, as well as on-board the ships lying in the Neva, no fire is permitted. In St. Petersburgh, in the same year, a fire was discovered in the vaulted shop of a furrier. In these shops, which are all vaults, neither fire nor candle is allowed, and the doors of them are all of iron. At length the probable cause was found to be, that the furrier, the evening before the fire, had got a roll of new cere-cloth, (much in use here for covering tables, counters, &c. being easily wiped and kept clean,) and had left it in his vault, where it was found almost consumed.

In the night between the 20th and 21st of April, 1781, a fire was seen on-board the frigate Maria, which lay at anchor, with several other ships, in the road off the island of Cronstadt; the fire was however soon extinguished; and, by the severest examination, little or nothing could be extorted concerning the manner in which it had arisen. The garrison was threatened with a scrutiny that should cost them dear; and, while they

were

were in this cruel suspense, the wisdom of the sovereign gave a turn to the affair, which quieted the minds of all, by pointing out the proper method to be pursued by the commissioners of inquiry, in the following order to Count Chernichef.

"When we perceived, by the report you have "delivered in of the examination into the accident that happened on-board the frigate Maria, that, in the cabin where the fire broke "out, there were found parcels of matting, tied "together with packthread, in which the soot of "burnt firwood had been mixed with oil, for "the purpose of painting the ship's bottom, it "came into our mind, that, at the fire which "happened last year at the hemp-warehouses, "the following cause, among others, was assigned, that the fire might have proceeded from "the hemp being bound up in greasy mats, or "even from such mats having lain near the "hemp; therefore, neglect not to guide your "farther inquiries by this remark."

As, upon juridical examination, as well as private enquiry, it was found that, in the ship's cabin,

bin, when the ſmoke appeared, there lay a bundle of matting, containing Ruſſian lamp-black, prepared from fir-ſoot, moiſtened with hemp-oil varniſh, which was perceived to have ſparks of fire in it at the time of the extinction, the Ruſſian admiralty gave orders to make various experiments, in order to ſee whether a mixture of hemp-oil varniſh and the forementioned Ruſſian black, folded up in a mat and bound together, would kindle of itſelf.

They ſhook forty pounds of fir-wood ſoot into a tub, and poured about thirty-five pounds of hemp-oil varniſh upon it; this they let ſtand for an hour, after which they poured off the oil. The remaining mixture they now wrapped up in a mat, and the bundle was laid cloſe to the cabin, where the midſhipmen had their birth. To avoid all ſuſpicion of treachery, two officers ſealed both the mat and the door with their own ſeals, and ſtationed a watch, of four ſea-officers, to take notice of all that paſſed the whole night through; and, as ſoon as any ſmoke ſhould appear, immediately to give information to the commandant of the port.

The

The experiment was made the 26th of April, about 11 o'clock A. M. in preſence of all the officers named in the commiſſion. Early on the following day, about 6 o'clock A. M. a ſmoke appeared, of which the chief commandant was immediately informed by an officer; he came with all poſſible ſpeed, and, through a ſmall hole in the door, ſaw the mat ſmoking. Without opening the door, he diſpatched a meſſenger to the members of the commiſſion; but, as the ſmoke became ſtronger, and fire began to appear, the chief commandant found it neceſſary, without waiting for the members of the commiſſion, to break the ſeals and open the door. No ſooner was the air thus admitted, than the mat began to burn with greater force, and preſently it burſt into a flame.

The Ruſſian Admiralty, being now fully convinced of the ſelf-enkindling property of this compoſition, tranſmitted their experiment to the Imperial Academy of Sciences; who appointed my friend Mr. Georgi, a very learned and able adjunct of the Academy, to make farther experiments on the ſubject, and to him I am chiefly

indebted for this account; though, being myself at the time upon a visit to some of my old parishioners at Cronstadt, I made myself acquainted with many of the circumstances on the spot.

The experiments of this ingenious chemist are of great importance, as they form a valuable addition to our knowledge on the subject; and are very remarkable from the occasion that led to these discoveries.

Previous to the relation of the experiments, it is necessary to observe, that the Russian fir-black is three or four times more heavy, thick, and unctuous, than that kind of painter's black which the Germans call *kien-rahm*. The former is gathered at Ochta, near St. Petersburg, at Mosco, at Archangel, and other places, in little wooden huts, from resinous fir-wood, and the unctuous bark of birch, by means of an apparatus uncommonly simple, consisting of pots without bottoms set one upon the other; and is sold very cheap. The famous fine German *kien-rahm* is called in Russia *Holland's black*. In what follows, when I speak of raw oil, it is to be understood of linseed-oil or hemp-oil; but most commonly the latter. The

varnish

varnish is made of five pounds of hemp-oil boiled with two ounces and a half of minion. For wrapping up the composition, Mr. Georgi made use of coarse hemp-linen, and always single, never double. The impregnations and commixtures were made in a large wooden bowl, in which they stood open till they were wrapt up in linen.

That I may not be too prolix, I will select and communicate only such of the experiments as were most remarkable, and succeeded best.

Three pounds of Russian fir-black were slowly impregnated with five pounds of hemp-oil varnish; and, when the mixture had stood open five hours, it was bound up in linen. By this process it became clotted; but some of the black remained dry. When the bundle had lain sixteen hours in a chest, it was observed to emit a very nauseous, and rather putrid, smell, not quite unlike that of boiling oil. Some parts of it became warm, and steamed much; this steam was watery, and by no means inflammable. Eighteen hours after the mixture was wrapt up, one place became brown, emitted smoke, and directly afterwards glowing fire appeared. The same thing happened in a second

 and

and a third place; though other places were scarcely warm. The fire crept slowly around, and gave a thick, grey, stinking smoke. Mr. Georgi took the bundle out of the chest, and laid it on a stone pavement; when, on being exposed to the free air, there arose a slow burning flame, a span high, with a strong body of smoke. Not long afterwards there appeared, here and there, several chaps, or clefts, as from a little volcano, the vapour issuing from which burst into flame. On his breaking the lump, it burst into a very violent flame, full three feet high, which soon grew less, and then went out. The smoaking and glowing fire lasted for the space of six hours; and afterwards the remainder continued to glow without smoke for two hours longer. The grey earthy ashes, when cold, weighed five ounces and a half.

In another experiment, perfectly similar to the foregoing, as far as relates to the composition and quantities, the enkindling did not ensue till forty-one hours after the impregnation: the heat kept increasing for three hours, and then the accension followed.

It

It is worthy of remark, that these experiments succeeded better on bright days than on such as were rainy; and the accension came on more rapidly.

In another experiment, three pounds of Russian fir-black were slowly impregnated with three pounds of raw hemp-oil; and the accension ensued after nine hours.

Three quarters of a pound of German *rahm* were slowly impregnated with a pound and a half of hemp-oil varnish. The mixture remained seventy hours before it became hot and reeking. It then gradually became hotter, and emitted a strong exhalation; the effluvia were moist, and not inflammable. The re-action lasted thirty-six hours, during which the heat was one while stronger, and then weaker, and at length quite ceased.

Stove or chimney soot, mostly formed from birch-wood smoke, was mingled with the above-mentioned substances and tied up; the compound remained cold and quiet.

Russian fir-black, mixed with equal parts of oil of turpentine, and bound up, exhibited not the least re-action or warmth.

Birch-

Birch-oil, mixed with equal parts of Russian fir-black, and bound up, began to grow warm and to emit a volatile smell; but the warmth soon went off again.

From the experiments of the Admiralty, and of Mr. Georgi, we learn, not only the decisive certainty of the self-accension of soot and oil, when the two substances are mixed under certain circumstances, but also the following particulars.

Of the various kinds of soot, or lamp-black, the experiments succeeded more frequently and surely with the coarser, more unctuous, and heavier, like Russian painters black, than with fine light German *rahm*, or with coarse chimney-soot. In regard to oils, only those experiments succeeded which were made with drying oils, either raw or boiled. The proportions of the soots to the oils were, in the successful experiments, very various; the mixture kindled with a tenth, a fifth, a third, with an equal, and likewise with a double, proportion of oil. In general, however, much more depends on the mode of mixture, and the manipulation; and, as Mr. Georgi often observed, on the weather: for, in moist weather,

the

the bundles, after becoming warm, would frequently grow cold again.

It is in all reſpects remarkable, that it ſhould never till now have been obſerved, that a mixture which has been made millions of times, in all proportions and quantities, for painting of ſhips, and the outſides of wooden houſes, and ſometimes intentionally, ſometimes accidentally, left covered or open, a longer or a ſhorter time, ſhould be capable of kindling of itſelf. It is highly probable, that, even on this occaſion, it was entirely owing to the attention of the Empreſs that it was made an object of inquiry, or even that it was at all obſerved.

Before I finiſh this paper, I will juſt mention a ſelf-accenſion, not noticed till of late, and that by Mr. Hagemann, an apothecary at Bremen. He prepared a boiled oil of *hyoſcyamus*, or henbane, in the uſual way, with common oil. The humidity of the herb was nearly evaporated, when he was called away by other affairs, and was obliged to leave the oil on the fire. The evaporation of the humidity was hereby carried ſo far, that the herb could eaſily be rubbed to powder. The oil

had

had loſt its green colour, and had become browniſh. In this ſtate it was laid on the ſtraining-cloth, and placed in the garden, behind the houſe, in the open air.

In the ſpace of half an hour, on coming again to this place, he perceived a ſtrong ſmoke there, though he thought the oil muſt long have been cooled: on cloſer inſpection, he found that the ſmoke did not proceed from the oil, but from the herb on the ſtraining-cloth; at the ſame time the ſmell betrayed a concealed fire.

He ſtirred the herb about, and blew into it with a bellows, whereupon it broke out into a bright flame. Had this herb been placed in the houſe near the fire, it might eaſily have been ſuppoſed that a ſpark had flown into it, which had cauſed the inflammation; but this was not the caſe; the herb had kindled of itſelf. We ſee from this, that thoſe who are intruſted with the preparation of boiled oils ſhould take care they do not give occaſion to dangers by fire, which may excite ſuſpicions of felonious deſigns, to the ruin of innocent perſons in their lives or reputations.

I am, &c. W. TOOKE.

XLI.

XVI. *Deſcription of a Crane for Wharfs; by Mr.* JAMES WHITE, *of Chevening, in the County of Kent.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Premium of Forty Guineas was adjudged to Mr. WHITE for this Invention.

THE properties of this crane, of which a deſcription and figure are hereafter given, are as follow.

Firſt. Its ſimplicity, conſiſting of a mere wheel and axle.

Secondly. Its only friction, excluſive of the pulleys, is that on the two gudgeons of the ſhaft; and one of theſe ſupports the weight of the

wheel, and of the man that works it, nearly in the direction of its point.

Thirdly. It is durable, as is evident from the two properties above-mentioned.

Fourthly. It is ſafe; for, it cannot move but during the pleaſure of the man, and while he is actually preſſing on the gripe-lever.

Fifthly. This crane admits of an almoſt infinite variety of different powers, and this variation is obtained without the leaſt alteration of any part of the machine.

If, in unloading a veſſel, there ſhould be found goods of every weight, from a few hundreds to a ton, and upwards, the man that does the work will be able ſo to adapt his ſtrength to each as to raiſe it in a ſpace of time proportionate to its weight; he walking always with the ſame velocity as nature and his greateſt eaſe may teach him.

It is a great diſadvantage in ſome cranes, the annihilation of which has juſtly become an object of the ſociety's attention, that the ſmalleſt weight muſt be as long in raiſing as the largeſt, unleſs the man turn or walk with a greater velocity, which

which tires him in a ſtill greater proportion. In other cranes, perhaps, two or three different powers may be procured; to obtain which, ſome pinion muſt be ſhifted, or freſh handle applied, or reſorted to. In this crane, on the contrary, if the labourer find his load ſo heavy as to permit him to aſcend the wheel without its turning, let him only move a ſtep or two toward the circumference, and he will be fully equal to the taſk. Again, if the load be ſo light as ſcarcely to reſiſt the action of his feet, and thus to oblige him to run through ſo much ſpace as to tire him beyond neceſſity, let him move laterally towards the centre, and he will ſoon feel the place where his ſtrength will ſuffer the leaſt fatigue by raiſing the load in queſtion.

It has been before obſerved that, if left alone, this crane will naturally reduce itſelf to a ſtate of reſt, even though a weight were ſuſpended to it. The means will appear to be, the gripe or brake at the top, and its lever, which ſtretches acroſs the diameter of the wheel at the height of a man's breaſt, when in an attitude of treading the wheel to the beſt advantage.

It may be neceſſary to obſerve, with reſpect to the dimenſions of the preſent crane, and ſome other peculiarities of its conſtruction, that what is now the frame, and ſeems to form a part of the crane, muſt be conſidered as a part of the houſe in which it is placed; ſince it would be moſtly unneceſſary, ſhould ſuch cranes be erected in houſes already built. With reſpect to the horizontal part, by walking on which the man who attends the gib occaſionally aſſiſts in raiſing the load, it is not an eſſential part of this invention, where the crane is not immediately contiguous to the gib, although, where it is, it would be certainly very convenient and economical.

In warehouſes, and where this ſhould be found unneceſſary, together with the frame-work above alluded to, this crane would be extremely ſimple and cheap; and this wheel, though of conſiderable diameter, occupies but little room, from its thinneſs and inclination. A ſlit in a floor, about two feet wide, with a ſupport above and below, for the axis, is all that is neceſſary to conſtitute and contain the crane; for, goods may be ſtowed both under the whole wheel, and above nearly

half

half of it; and there would be ample room to ſtow a large quantity of goods properly ſheltered from the weather. Hence alſo it appears, that the houſe would diminiſh the wharf-room much leſs than many others, ſtanding, on the whole, on leſs ground. One man's weight alone, applied at the extremity of the wheel, would raiſe upwards of a ton; and it need not be added, that a ſingle-ſheaved block would double that power. Suffice it to ſay, that the ſize may be varied in any required *ratio*; and that this wheel will give as great advantage, at any point of its plane, as a common walking-wheel of equal diameter, as the inclination can be varied at pleaſure, as far as expediency may require.

Explanation of the Figure.

(See Plate VII.)

A, Fig. 1, a circular inclined plane, moving on a pivot underneath it, and carrying round with it the axis E.

A perſon walking on this plane, and preſſing againſt the lever B, throws off the gripe D, by

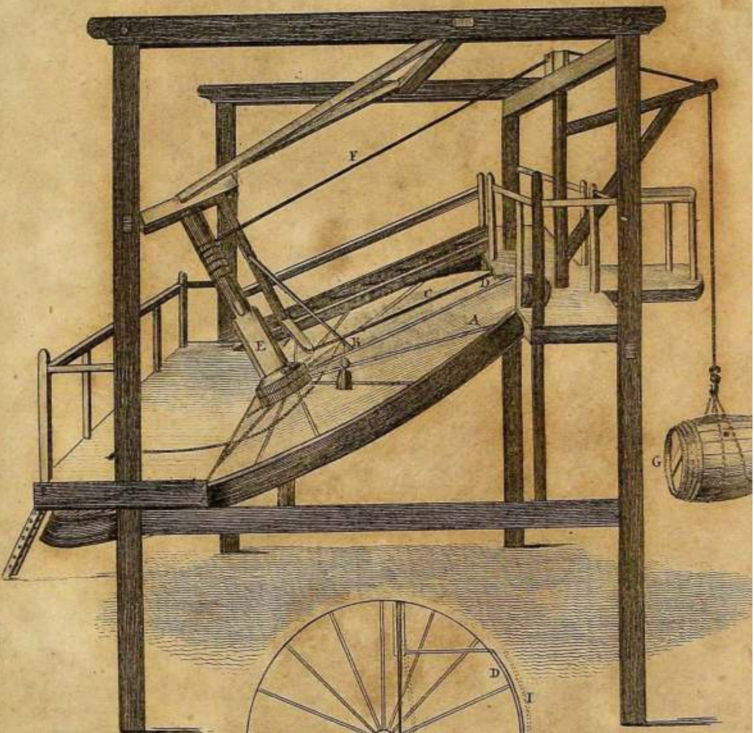
means

means of an iron rod C; and thus admits the plane and its axis to move freely, and raiſe the weight G, by the coiling of the rope F round the axis E.

To ſhew more clearly the conſtruction and action of the lever and gripe, a plan of the circular inclined plane, with the lever and gripe, is added, (ſee Fig. 2) where B repreſents the lever, D the ſpring or gripe. In this plan, when the lever B is in the ſituation it now appears, the ſpring or gripe D preſſes againſt the periphery of the plane, as ſhewn by the double line, and the machine cannot move but when the lever B is preſſed out to the dotted line H, the gripe is alſo thrown off to the dotted line I, and the whole machine left at liberty to move. One end of a rope, or cord, of a proper length, is fixed near the end of the lever B, and the other end made faſt to one of the uprights, ſerving to prevent the lever moving too far, when preſſed by the man.

XVII.

Fig. 1.



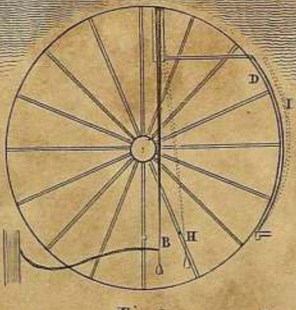


Fig. 2.

XVII. *Deſcription of a Pump-Engine; or an Apparatus to be added to a common Pump, to anſwer the Purpoſe of a Fire-Engine; by Mr.* Benjamin Dearborn.

WITH A PLATE.

From the Memoirs of the American Academy of Arts and Sciences.

A B C D (Plate VIII. Fig. 1.) repreſents a pump in the form of a common ſhip-pump. E its ſpout. F a ſtopper. D *d* is a plank-cap, fitted with leather under it to the pump, and ſcrewed down by the ſcrews *a b*; having a hole in the centre, for the ſpear of the pump to paſs through, round which a leather collar is made, as at *c*. *g* is a nut for the ſcrew *b*. *f* is a ſquare piece of wood, nailed acroſs one end of the cap, the ſcrew *a* paſſing through it and the cap; through this piece and the cap a hole is made, communicating with the bore of the pump. G G is a wooden tube, (of any required length, or number

number of joints,) made fquare at the lower end, and hollowed to receive the cock; the upper end being made with a nice fhoulder. *e* is a wooden cock, which opens or fhuts the communication between the pump and the tube, having a handle on the oppofite fide, with a lock, if neceffary. *h h* are ferrules, to prevent the tube from fplitting. H H are braces, each of which muft have another croffing it, as nearly at right angles as may be. At *i i* are irons in the form of a ftaple, going round the tube, and through the braces, having holes in their ends for forelocks. K L M N is a head, made of five pieces of wood; *k l m n*, a fquare piece, with a hole in the lower end, to receive the end of the tube, and refts on the fhoulder *o p*: on the lower end of this head a leather is nailed, having a hole in its centre, fimilar to the hole in the wood. Another leather, of the fame form, is put on the top of the tube, and a circle of thin plate-glafs between them; the two leathers and the brafs being preffed between the lower end of the head and the fhoulder of the tube; their edges are reprefented by *o p*. K N and L M are the edges of two pieces of plank,

which

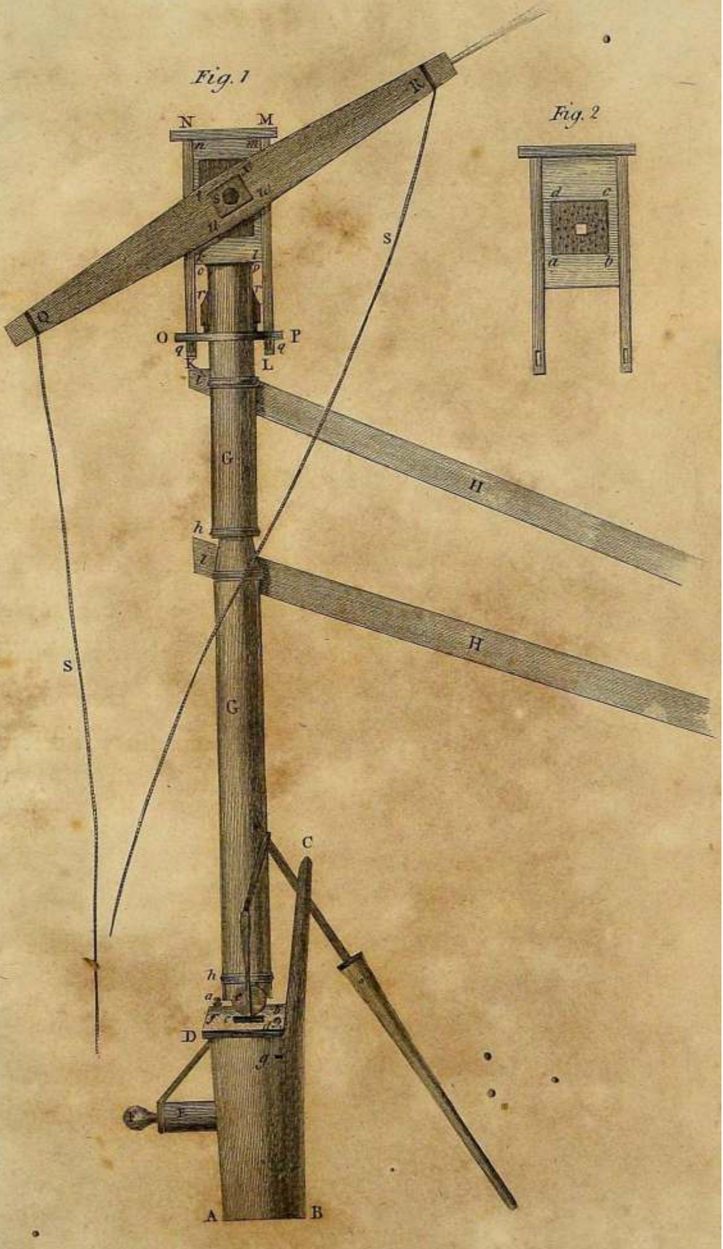
which are as wide as the head, and nailed faſt to it; each of them having a tennon going through a mortice in the end of the piece O P; each tennon has a hole for a forelock at *q*. O P is a piece of plank, as wide as the ſides, having a hole in its centre through which the tube paſſes, and a mortice in each end, for the tennons to paſs through. N M is a cap. *r r* are two pieces nailed on the ſide of the tube, with a truck in the lower end of each, to leſſen the friction of the head in its horizontal revolution. *q q* are forelocks, to wedge the head down, and prevent the water from finding a paſſage out at the joint *o p*. Q R is a wooden conductor; the end Q being ſolid, the end R bored with a ſmall augur; *s* is a bolt, going through the conductor and head, ſecured on the back with a forelock or nut; this bolt is rounded near the head, and ſquare in the middle. *t u w x* is a piece of iron, or braſs, to prevent the head of the bolt from wearing into the wood. S S are ropes to direct the conductor.

Fig 2. is the head without the conductor. *a b c d* is a thick braſs plate, perforated to prevent dirt

from clogging the conductor, and nailed with leather under it to the head. The fquare hole in the centre is made to the fize of the bolt, and prevents it from turning. The conductor has a hollow cut round the bolt on the infide, as large as the circle of holes in the brafs; round which hollow, on the face of the conductor, a leather is nailed, which plays on the margin of the brafs plate when the conductor turns.

I have raifed a tube of thirty feet on my pump; but the feverity of the feafon prevents my completing it, having fo far executed it only as for one perfon to work at the brake; I can myfelf throw water on the top of a neighbouring building, the neareft part of which is thirty-feven feet from the pump, and between thirty and forty feet high.

Fig. 1



XVIII. *Conclusion of Mr.* Davies's *Observations on watering Meadows.*

(from p. 61.)

THE water-meadows are laid up for a second crop, in some instances, but this is only usual when hay is scarce; not that it is supposed to hurt the land, but the hay is of that herbaceous soft nature, and takes so long time in drying, that it is seldom well made. It is usually of much greater value to be fed with dairy-cows; and, for that purpose, a flush of after-grass, so early and so rank, will be precisely of the same comparative service to the dairy as the spring-feed has been described to be for ewes and lambs: the cows remain in the meadows till the drowner begins to prepare for the winter watering.

Water-meadows safe for sheep in spring, but will rot them in autumn. Water-meadows are reckoned to be perfectly safe for sheep in the spring, even upon land that would rot sheep if it was not watered, but in the autumn the best water-meadows

are ſuppoſed to be dangerous. This is at preſent an inexplicability in the operations of nature; and a diſcovery of the reaſon might perhaps lead, in ſome meaſure, to a diſcovery of the cauſes of the rot in ſheep. But the circumſtance itſelf is rather an advantage than a diſadvantage to this diſtrict, as it obliges the farmers to keep a few dairy cows, to feed the water-meadows in autumn, and to provide artificial graſſes, or other green crops, for their ſheep, during that period.

Proper ſoils for water-meadows. From what has been ſo repeatedly urged, or the neceſſity of making water-meadows dry as well as wet, every reader muſt have inferred the advantage of having them, if poſſible, on a warm abſorbent bottom *.

* There is a ſtriking proof of the truth of this remark in the water-meadows near Hungerford, and particularly at Standen. Although they are laid out in no regular plan, and, in many inſtances, there are no drains to empty the water-carriages, yet the gravel bottom is ſo very abſorbent, that the water will ſoak out in a few hours, and the meadows be left as dry as if they were watered on the moſt ſyſtematic plan: and few meads in the county produce better crops, either of ſpring-feed, or of hay.

The

The bottom, or ſub-ſoil, of a water-mead is of much more conſequence than the quality, or the depth, of the top-ſoil. Not but that land on peaty or clay bottoms may be conſiderably improved by watering, (and there are many good water-meadows on ſuch ſoils,) but they are not ſo deſirable, on account of the difficulty of draining the water out of them, and making them firm enough to bear treading. A looſe gravel, or, what perhaps is ſtill better, a bed of broken flints, with little or no intermixture of earth, whenever it can be obtained, is the moſt deſirable bottom.

On many of the beſt meadows in this diſtrict, where the bottom is a warm abſorbent gravel, or rather a bed of broken flints, the ſoil is not ſix inches deep; and that depth is quite ſufficient, in thoſe ſeaſons when water is plenty, as the graſs will root in the warm gravel, in preference to the beſt top-ſoil whatever, and ſuch meadows always produce the earlieſt graſs in the ſpring. Nor is it ſo very material of what kinds of graſſes the herbage is compoſed when the meadow is made; that kind will always predominate which agrees beſt with the ſoil and the water, provided the ſup-

ply

ply of water is regular and conſtant every winter, otherwiſe that kind will predominate which will bear wet and dry; and ſome of the worſt graſſes, in their native ſtate, will become the beſt when made ſucculent by plenty of water.

Long-graſs meadows. Nature has given a ſtriking leſſon on this ſubject, in this very diſtrict, viz. In the two ſmall meadows at Orcheſton, (ſix miles north-weſt of Ameſbury,) uſually called the *Wiltſhire long-graſs meads.*

Theſe meadows join together, and contain, in the whole, only two acres and a half; and yet the crop they produce, in a favourable year, is ſo immenſe, and of ſo good a quality, that the tithe-hay of them was once (according to the information of the tenant) ſold for five guineas.

Much has been ſaid, and little underſtood, about thoſe meadows, and the graſs they produce. Many propoſals and attempts have been made to propagate the graſs: and many ſkilful botaniſts have returned from the ſpot without finding out which was the long graſs, its appearance being ſo very different in different ſeaſons. It was not till lately that it was diſcovered by Mr. Sole, of Bath,

Bath, and communicated to the Bath Society, that the greateſt part of the herbage of theſe meadows was nothing more than the *black couch* or *couchy bent*, (*Agroſtis ſtolonifera*,) one of the worſt graſſes, in its native ſtate, the kingdom produces, and the peculiar plague of farmers in this particular diſtrict. It uſually abounds in ſuch arable land as is too poor to bear the *white couch*, (*Triticum repens*,) and is the general and almoſt only herbage of the old burn-beaked worn-out downs; and, in that ſituation, is of that coarſe, hard, wiry nature that no cattle will eat it. It forms a thick tough rug over the land, that preſerves itſelf, and kills every thing elſe; but, in theſe meadows, when abundantly fed with water, it is of a juicy, ſucculent, nouriſhing quality, as graſs, and makes the moſt deſirable hay in the diſtrict, particularly for ſheep.

Theſe meadows lie in the upper part of the bourn that runs from Tilſhead to Stapleford, and, in ſome winters, the rivulet that paſſes through them is very inconſiderable. They are not laid out in regular form for watering, the ſupply of water being too irregular, but depend on the

floods

floods entirely; and, being ſituate at a ſharp turn of the valley, which is narrow at that ſpot, the water makes an eddy, and depoſits its ſediment upon them. The bottom is almoſt an entire bed of looſe flints, ſo that the roots ſhoot freely in it, and produce ſtrong ſucculent ſhoots, which fall down, and, taking root at the joints, ſhoot out, and drop, and root again; ſo that the ſtalk is frequently eight or ten feet in length from the original root; and, though the crop is exceedingly thick on the ground, it is, perhaps, not eighteen inches high.

Although this graſs is moſt abundant in theſe two meadows, it is alſo very predominant in the greateſt part of the meadows below it, on the ſame ſtream; and, whenever the winters are productive of floods, the graſs in all of them is abundant in quantity, ſucculent and juicy in quality, and the hay exceedingly nutritive; but, in a year ſcarce of water, their produce is very ſmall indeed, and of a very bad quality.

On examination of other meadows, in different bourns of this diſtrict, the ſame graſs appears uniformly to abound in thoſe that are ſituated near

the

the ſpring-heads, and which in ſome years have plenty of water, and in ſome none at all. The ſame remark is as uniformly made on its variation in quantity and quality, according to the wetneſs or dryneſs of the winter; and the moſt probable way of accounting for it is, that it is almoſt the only graſs, common to water-meads, that will ſtand wet and dry; for, though it will live, and indeed flouriſhes moſt, when under water, yet no dry weather will kill it.

North, or, more properly, North-West, Wiltshire.

Notwithſtanding the ſyſtem of watering meadows is carried to ſo great an extent and perfection in South Wilts, it has not been generally adopted in North Wilts. There is not, indeed, the ſame occaſion for water-meadows in one diſtrict as in the other; but it does not follow that they may not be uſeful, though not equally indiſpenſable in both.

In the north-weſt, or arable, part of this diſtrict, where water-meadows are the moſt deſirable, the

ſprings are in general too ſmall, and the land is too abſorbent, to be made much uſe of in that way. Where they can be uſed, they certainly ought not to be neglected; but there are ſeveral ſituations in this diſtrict, where ſome good water-meadows may be made, though not in very great quantity. On the banks of the Avon, and on ſome of the principal branches that lead to the Thames, water-meadows, though very practicable, are not much in requeſt; the land being ſuppoſed to be good enough already.

But, although it may, perhaps, be not eaſy to prove that watering thoſe rich meadows would improve their quality, it certainly would be of ſome advantage, to a dairy-farmer, to make the winter a month ſhorter, that he might be able to turn his cows into a fluſh of graſs early in April, inſtead of waiting till May; eſpecially in a country where, on account of the great demand for, and high price of, winter veal, a great part of the calves are ſold off fat by the beginning of April; and, if at that period the cows have no other food but hay, unleſs the hay is very good, they frequently ſhrink their milk, and never fully recover it during the whole ſummer.

A few

A few of the dairy-farmers have ſeen that advantage in this light, and have made water-meadows; particularly near Somerford, where, though the expence muſt have been, at leaſt, twelve pounds an acre, the improvement pays exceeding good intereſt for it. The very advantage of ſuch land, not only requiring no manure itſelf, but affording manure for other land, is an object of more conſequence than is generally imagined.

Objections againſt water-meadows refuted. In a country like North Wiltſhire, where graſs-land is plenty, and hay, of courſe, not ſo great an object as it is in South Wiltſhire, it has been frequently remarked, that one of the great objects of a water-meadow, that of producing a large and almoſt certain crop of hay, is loſt; becauſe, in ſuch a country, hay of a much better quality than what uſually grows in water-meadows is always to be got at a reaſonable price. I anſwer to this, that the coarſeneſs uſually attributed to water-mead hay is, in general, not ſo much the fault of the herbage, as the covetouſneſs of the owner, in letting it ſtand, to increaſe the quantity, till it is too ripe.

Water-mead hay, if cut young, is not only as good as that of dry meadows, but cows are more fond of it, on account of its peculiar ſoftneſs, than of the hard *benty* hay that is produced on upland meadows, and it will produce more milk; though I will allow that, on that very account, it is not ſo ſaleable, nor, perhaps, ſo proper for horſes.

But, perhaps, it would not be difficult to prove, that water-meadows, in many counties, and particularly thoſe of dairy-farms, will anſwer a better end to be ſummer-fed than to be mown at all. The advantage of the firſt fluſh of graſs, a month before the upland meadows will produce it, is already pointed out, and is obvious to every one. When this is eaten up, the land intended for ſummer feeding will be ready to take the ſtock. The water may then be thrown over the water-meadows for a fortnight, and a new ſupply of graſs produced, that will again take the cows, by the time they have eaten off the firſt ſhoot of the ſummer paſtures, and then they may be fed during the ſummer; and the quantity of graſs that will be produced, and the particular milky nature of

that

that graſs, are inconceivable to thoſe who have not tried it, eſpecially during a dry ſummer.

In caſe of a wet ſummer, the meadows will not want watering after the ſecond time, and indeed the drier they can be kept the better; but, if the ſummer be dry, the water ſhould be thrown over them whenever they appear to want it, and the cattle taken out, until the ground is dry and firm again. Two days watering, and, in very hot weather, even a few hours, will be ſufficient; always remembering to ſtop it, before the water begins to leave a ſcum on the land.

This plan, of ſummer-feeding water-meadows, has been adopted by a few farmers in this diſtrict, with ſucceſs. In South Wiltſhire it has been reduced to a ſyſtem, (in the neighbourhood of Hungerford,) and applied to breeding lambs, and fatting them for the London Market, in a way that is well worthy of imitation in thoſe countries where the ſheep-fold is not indiſpenſably neceſſary.

XIX. *Experiments on the Means of improving the Veſſels uſed in Cooking; by Mr.* SVEN RINMAN, *Member of the Royal Academy of Stockholm.*

From the TRANSACTIONS of the ſaid ACADEMY.

THE Veſſels which are uſed for the preparation of our food are, without doubt, one of the moſt important articles in our domeſtic œconomy; for, thoſe made of improper materials may not only communicate taſte and colour to the ſubſtances cooked in them, but they may alſo ſeriouſly affect the health of thoſe who uſe them. The means of bringing them to a greater degree of perfection deſerves, therefore, to be carefully ſought after; but to find thoſe means is a taſk of great difficulty, becauſe the veſſels ſhould not only be free from the defects above-mentioned, but they ſhould be ſufficiently ſtrong to reſiſt falls, or blows, and they ſhould likewiſe be capable of being ſold at a price that all ranks of people can afford to pay.

If

If we could conſider it as an object of no great conſequence, that they ſhould be able to ſupport all the alternatives of heat and cold, and that they ſhould alſo bear to be handled in a rough manner without danger of breaking, there could be nothing better wiſhed for than various kinds of veſſels which we have long been poſſeſſed of, made of clay, of earth, of ſtone, &c. alſo thoſe called by M. Reaumur *glaſs porcelain*; and, above all, ſuch as are made of *ſmectis*, or *lapis ollaris*; for, if we except ſtrength, they poſſeſs all the good qualities we can deſire. Among the number of theſe, I think it right to commend thoſe made in this kingdom, and eſpecially in Jæmtland, of a common ſort of *lapis ollaris* which is of a greeniſh colour, greaſy to the touch, and compoſed of crooked fibres; it is very little acted upon by the nitrous acid, and only in ſome parts, where that acid produces ſpots which have the appearance of lime; the vitriolic acid alſo has but a very ſlight action upon it, and the vegetable acids none at all; it not only ſupports a great degree of heat, but it alſo bears, without any damage, the moſt ſudden changes of heat and cold; it does not, even in

the ſmalleſt degree, affect the colour, or taſte, of the victuals cooked in it; in ſhort, it does not communicate to them any foreign matter, although, by a chemical analyſis, this ſtone appears to contain a ſmall quantity of magneſia; which, however, cannot mix itſelf with the victuals, and, if it did, it could not be conſidered as prejudicial to health. Veſſels of this kind are ſold at a very moderate price, and, if uſed with care, will laſt longer than the life of man. Of their durability I have convinced myſelf by long experience; and, by having them hooped or bound with iron, they may be rendered capable of bearing pretty ſevere blows.

Theſe veſſels, however, may not be quite fit for the uſe of the common people, being ſtill too brittle, if they are careleſsly handled. For reaſons of this nature, the Society of Emulation in Paris propoſed as a prize-queſtion, in the year 1779, "To diſcover a compoſition fit for making kitchen-utenſils, which ſhould be free from "the diſadvantages attending copper, lead, tinned veſſels, glazed earthen-ware, &c. which "ſhould be as ſtrong as poſſible; leſs coſtly than

"the

"the vessels used at present; and which should "be able to bear the highest degree of kitchen "fire, and the most sudden changes from heat to "cold."

This proposal required so many conditions to be fulfilled, that it was hardly possible to give a satisfactory answer to the question. The vessels commonly used in kitchens are formed either of stone, of glass, of earth, or of metal. It is not natural to expect vessels, made of the first-mentioned materials, should be able to resist blows, or falls, for any length of time, especially if they are handled without care. Of course, the Society had not in view any composition of a nature similar to those made by potters; which, indeed, bear successive changes of heat and cold very well, but which are, at the same time, very brittle; such compositions have long been known, and are used in France and elsewhere.

If (on account of its greater durability) we have recourse to the last-mentioned substance, namely, metal, we may have vessels of the imperfect metals at a tolerable low price, and we shall probably fix upon either iron, or copper; but both

theſe have the defect common to all the imperfect metals; viz. they are acted upon by all kinds of acids, and conſequently are more or leſs dangerous with reſpect to health, and therefore by no means fit for the compoſition of kitchen-utenſils. Neither muſt we flatter ourſelves with the hopes of obtaining, by any mixture of the imperfect metals, a compoſition free from the above mentioned inconveniences; that it is impoſſible to do ſo, I could prove by many experiments.

The metallic mixture the eaſieſt to obtain, the cheapeſt I know of, and which is leſs liable to ruſt, and reſiſts the action of acids more than any other, is iron melted with a certain proportion of tin; of this it is very eaſy to form veſſels of any ſhape, but I cannot ſay that it is incapable of being acted upon by the air, or by acids. If nickel were more eaſily procured, (the nature of which is as yet but little known,) perhaps the property it poſſeſſes, of not being diſſolved by means of vitriolic acid, might render it more proper than tin to be mixed with iron, for the purpoſe of forming kitchen-utenſils. But, for want of a ſufficient quantity of nickel, no certain

ex-

experiments upon that ſubject have yet been made with it; there is not, however, any reaſon to ſuppoſe that we could, even by its means, render iron abſolutely inſoluble.

It is equally evident, that coating one imperfect metal with another muſt be inſufficient to anſwer the ends deſired; we have conſequently no way left, except to try to correct the brittleneſs of earthen veſſels, by the help of ſome metal; or to guard againſt the ſolubility of the harder metals, by covering them with ſome vitreous matter, ſo that they ſhall be free from the inconveniences attendant on glazed earthen-ware.

Without any intention of being a candidate for the premium offered by the Society of Emulation, I have made a great number of experiments on iron, chiefly with the view of preventing, or at leaſt diminiſhing, its deſtructibility in the fire; I have likewiſe tried to cover it, and alſo copper, with ſome vitreous compoſition, of a cheap price, and one which ſhould not only reſiſt the action of acids, but, at the ſame time, ſhould bear the ſtrongeſt boiling heat, and the ſucceſſive changes of heat and cold.

I freely confeſs, indeed, that the attainment of the above ends will not furniſh a complete ſolution of the queſtion propoſed; in which it ſeems to be required, that the veſſels, and their coating, ſhould be able to reſiſt blows and falls, like tinned veſſels, or thoſe made of ſome metallic mixtures; this, however, cannot be hoped for until we ſhall find out the art of making glaſs malleable, and at a ſmall expence.

Neverthelefs, I have long thought, that inſtead of tinning copper veſſels, which is but an imperfect manner of preventing their bad effects, it might, perhaps, be poſſible to prevent them by means of ſome coating which ſhould not have the defects of tinning; and which coating ſhould alſo, when applied to iron, take from it the inconvenience of ruſting, and that of blackening many ſorts of victuals, when they are dreſſed in it; and therefore, in hopes of contributing ſomething towards the attainment of ſuch deſirable ends, I take the liberty to offer to the academy a ſuite of experiments which may perhaps, to a certain degree, ſatisfy the deſires of the public; or, at leaſt, may engage ſome more experienced philſoſopher

sopher to carry so useful a subject to its greatest perfection.

It must be previously observed, that the following experiments were made upon small vessels of copper, or of hammered iron; that they consist in giving to those vessels a coating of what may be properly called *enamel*; and that the experiments were most commonly made in an assaying-furnace, but sometimes in a coal-fire, kept up by a strong blast from a pair of bellows.

SECTION I.

Of the Manner of enamelling Copper Vessels.

Every one knows that various colours, and figures, are applied upon copper by means of an art which is called enamelling, and there can be no doubt but that those who are masters of this art may extend it to the coating of vessels used in cooking.

The most common, and the cheapest, kind of white enamel that is to be met with in the shops, (which is an opaque white glass, composed of powdered quartz, of glass of lead, and of calx of tin,) was tried for coating kitchen-utensils; and I found that it was excellent for the purpose, as it produced

produced a coating that was not only clean and agreeable in its appearance, but poſſeſſed likewiſe all the power of reſiſting the action of fire, and of acids, that could be deſired. But, as it is very difficult to apply, is very dear for common uſe, and is beſides conſidered as not being capable of reſiſting violent blows or falls, I made various experiments with ſubſtances of leſs price, of which the following may, perhaps, be thought worthy of being related.

Experiment I. The white ſemi-tranſparent fluor-ſpar, which is found in great quantity near the copper mines of Yxsjoe, in the pariſh of New Kopparberg, was reduced into a fine powder, with an equal quantity of unburnt gypſum, and afterwards calcined in a ſtrong fire, with a white heat; the whole being, from time to time, carefully ſtirred. The veſſel which I intended to coat, having firſt been wetted by dipping it in water, had as much of the aforeſaid powder applied to its inſide, by means of a very fine ſilk ſieve, as would adhere to it of itſelf, or could be made to do ſo by preſſing it with the finger. After this veſſel had been dried, and gradually heated, it was expoſed to a ſudden and violent heat; partly in a

coal-

coal-fire, kept up by a pair of bellows, (the veſ-ſel being at the ſame time covered, ſo that no coals or aſhes could fall into it,) and partly in an aſſaying furnace.

In the coal-fire, and with a heat as violent as is commonly uſed to make copper-ſolder run, the mixture was melted, in about the ſpace of a minute, into an opaque white enamel, which evenly covered the ſurface of the copper, and fixed itſelf pretty firmly to the metal; it alſo bore hard blows without breaking, and reſiſted the trials made by boiling things in it, and by applying acids to it. The forementioned mixture was alſo reduced into a fine powder, in a glaſs mortar, and made into a ſort of thin paſte with water; it was then applied to the veſſel with a ſmall bruſh, an operation as eaſy as that of applying any other wet colouring-matter. I likewiſe tried this paſte by covering veſſels with it, in the ſame way the potters apply their common glazing for ſtone-ware; by both the above-mentioned proceſſes I obtained a very ſmooth coating, particularly by the latter, which is more quickly performed; when the paſte is applied, the veſſel ſhould be made a little warm, ſo alſo ſhould the paſte itſelf.

If the constituent parts of these two substances be considered; that is to say, that gypsum is composed of calcareous earth, saturated with vitriolic acid; and fluor-spar, of a particular acid, united to siliceous earth; also that the whole, when put into the fire without the addition of any other substance, is, of all earthy or stony mixtures, that which the most easily melts into an opaque white glass, not very brittle: and if, on the other hand, the action of acids be attended to, we shall easily conceive these substances must attach themselves strongly to copper, and that the varnish, formed by them, cannot afterwards be dissolved or acted upon by acids.

The greatest difficulty attending on this simple mixture is, the strong and sudden heat necessary to apply it with effect; that heat being greater than is commonly to be obtained in an assaying furnace. On that account, I have endeavoured to render it more fusible, by the addition of some other substance: in the following experiments, it will easily be seen which succeeded, in that respect, and which did not.

TO BE CONCLUDED IN OUR NEXT.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XV.

Printed by JOHN NICHOLS, Red-Lion-Paſſage, Fleet-Street, London.

XX. *Specification of the Patent granted to Mr.* THOMAS CONNOP, *of Sheffield, in the County of York, Whiteſmith; for his Invention of a Machine or Engine for batting Cotton and Wool.*

WITH TWO PLATES.

Dated Jan. 12, 1795.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid Thomas Connop do hereby declare, that my ſaid invention, of a machine or engine for batting cotton and wool, is deſcribed in the plans hereunder drawn and ſet forth, and in the explanation or deſcription thereof herein-

hereinafter mentioned and contained; that is to ſay, Fig. 1. (Plate IX.) ſhews the conſtruction of a machine, in which the rods or beaters are made to remove to and from the cotton or wool; where *a* is a bevel wheel, fixed on the axis *b*, which may be turned by an upright ſhaft; or, inſtead thereof, a pulley may be ſubſtituted, to be turned by a ſtrap from a num*. On the axis *b* is alſo affixed the half wheel *c*, which, acting on the rack *d*, affixed to the centre part of the frame A A, movable on the large frame B B, cauſes the ſmall movable frame A A to recede from the corded frame D, on which the cotton or wool is laid, in the ſituation as repreſented in this figure. The ſame motion, operating on the bevel wheel *e*, affixed at the oppoſite end

* Compared with the record in the office.

We ſo frequently meet with words, in Patents, which we confeſs ourſelves unable to comprehend, that we have reſolved, in future, (leſt they ſhould be conſidered as errors ariſing from *our* negligence,) to point them out by a note; at the ſame time we aſſure our readers that we ſhall never paſs ſuch words till we have, as our note will expreſs, compared them with the record in the office.

of

of the axis *b*, turns the wheels *f*, *g*, and *h*, (as is reprefented in Fig. 2,) and is communicated to the axis *i*, on which is affixed the half wheel *k*, which, acting upon the rack *d*, in a reverfe direction from the half wheel *c*, caufes the movable frame to approach the cotton or wool. The elevation of the rods is effected by the operation of the wheel *m*, affixed on the end of the axis *i*, which, acting upon the horizontal wheel *n*, turns the upright axis *o*, on the top of which the brafs pinion *p* is fixed; this again, acting upon the brafs wheel *r*, turns a fliding axis, at the end of which the wheel *s* is fixed, which moves the wheel *t*, on the axis of which are affixed the fegment wheels *u*, *u*, *u*, *u*; and thefe, acting upon the quadrant wheels *v*, *v*, *v*, *v*, elevate the rods, in the manner hereafter more particularly mentioned in the defcription of the machine reprefented in Fig. 3. Inftead of the half wheels *c* and *k*, may be fubftituted levers upon the fame axis, at the extremity of which, in order to prevent friction, friction rollers or pulleys may be affixed; and, inftead of the iron rack, a projection of wood, or

iron, on the underſide of the frame; the levers, alternately preſſing againſt the projecting part of the frame, will produce the ſame motion as the half wheels *c* and *k*.

Fig. 3, (Plate X.) ſhews the conſtruction of a machine, in which the frame, whereon the cotton or wool is placed, is made to move to and from the batting rods. At A, in this figure, is repreſented a pulley, (which may be worked as above-mentioned in the deſcription of the machine repreſented in Fig. 1,) fixed on the axis B, which, in turning, moves the ſegment wheels *a*, *a*, *a*, *a*,; theſe, acting on the quadrant wheels *b*, *b*, *b*, *b*, elevate the rods, till the ſegment wheels arrive at the points where the cogs are diſcontinued; the quadrant wheels being then relieved, the rods immediately fall upon the corded frame *h h h h*, (on which the cotton or wool is placed,) by the action of ſpiral ſprings fixed from the pulleys *i*,*i*,*i*,*i*, at the bottom of the rods. During this period the wheel C, acting upon the wheel D, turns the axis on which are placed the braſs wheels E, F, and G, and the iron wheel H, which, acting upon the wheel I, com-

communicates a ſimilar motion to the ſegment wheels *d, d, d, d,* and the quadrant wheels *e, e, e, e;* the ſituation of which, on the axis K, being reverſed from thoſe at B, the alternate elevation of the rods is effected. The braſs pinions E, F, at the ſame time, acting upon the horizontal wheels L, L, move the cranks M, M, and communicate to the frame *g g g g* an alternate motion, to and from the ſides of the machine, ſo that the ſtrokes of the rods may be equally diſtributed to the different parts of the cotton, or wool. A ſimilar motion, to and from each end of the machine, is produced upon the frame *h h h h,* by the action of the braſs wheel G on the pinion P; on the axis of which is placed the wheel R, which, acting upon the vertical wheel S, communicates a rotative motion to the crank T, which, preſſing alternately againſt the ſides of the boards *k, k,* ſuſpended from the centre of the corded frame, produces the motion above-mentioned. Circular, inſtead of ſegment and quadrant, wheels may be uſed in the above-deſcribed machines, ſo that they may be what is termed always in gear, by

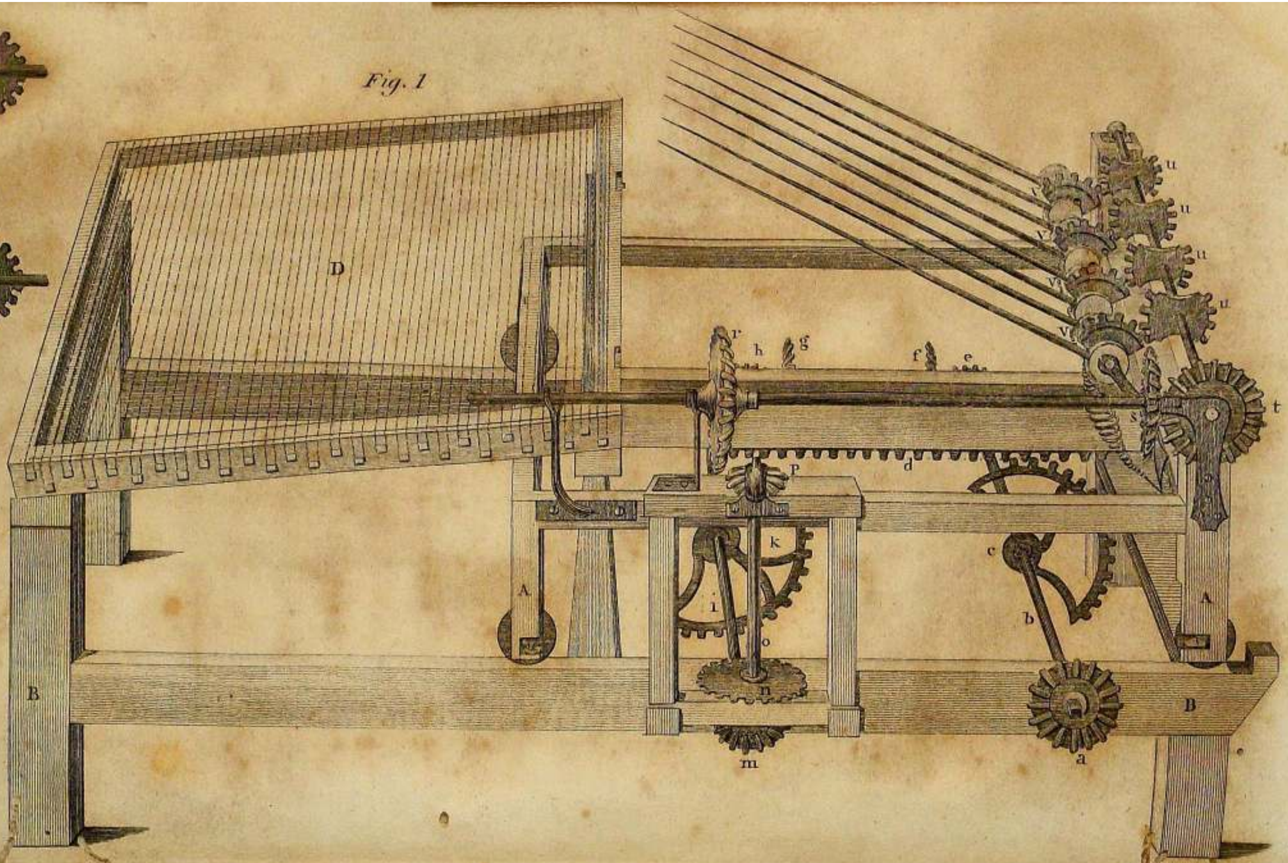
fixing

fixing a ſtud or catch upon the wheels that are upon the ſame axis with the rods; the pulleys at the bottom of the rods being movable, inſtead of fixed, as in the laſt deſcribed machine; and having a ſtud or catch, to lock in with the adjoining wheel. A knuckle, or projecting part, muſt alſo be made upon the pulleys; and iron rods to project from the frame, which, paſſing between the pulleys and iron wheels, in their courſe, relieve the catches or ſtuds from each other, at the point where the knuckles approach the projecting rods of the frame. The batting rods, being releaſed, give the blow on the cotton, or wool, by the action of the ſpiral ſprings, as before-mentioned, and are taken up again by the meeting of the ſtuds in the pulleys and wheels, which are made to approach each other by ſcroll ſprings, fixed behind the pulleys. In witneſs whereof, &c.

XXI.

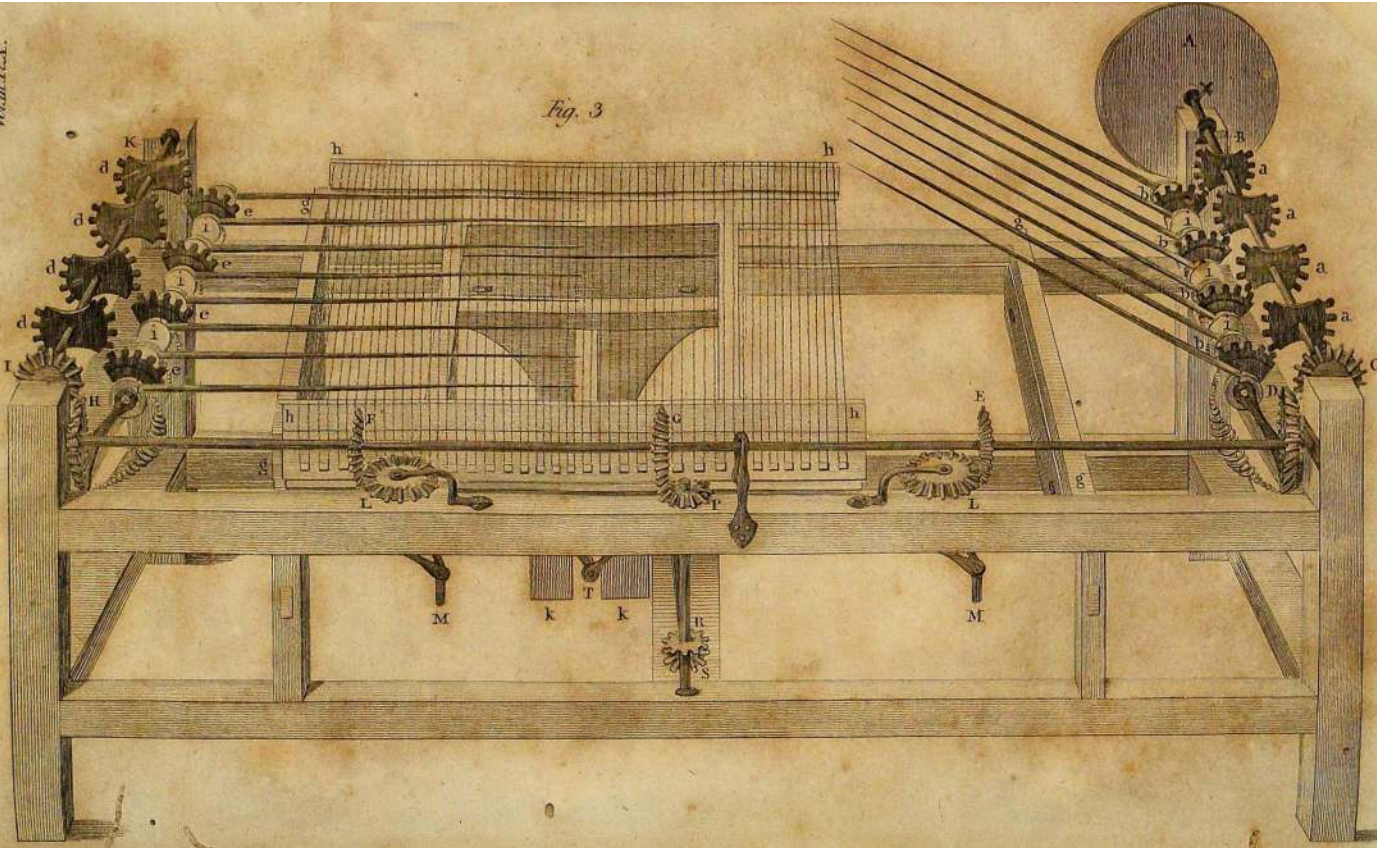
Fig. 2

Fig. 1



Vol. III. Pl. X.

Fig. 3



XXI. *Specification of the Patent granted to Mr.* JOHN MILES, *of Birmingham, in the County of Warwick; for his Invention of making Lamps, in different Forms, ſo as to give perfect Light, though ever ſo much agitated; or to be uſed in Halls, &c. or for other Purpoſes, where Motion is not required.*

Dated Feb. 12, 1787.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo, I the ſaid John Miles do hereby declare, that my ſaid invention of making lamps in different forms, and of any kind of metal or metallic ſubſtances, to be uſed without inconvenience on horſes, carriages, breaſts of men, or any body under motion, ſo as to give perfect light, though ever ſo much agitated, or to be uſed in halls, on ſtaircaſes, tables, deſks, or for other purpoſes, where motion is not required, is performed in the following manner; that is to ſay, I take of any kind

kind of metal, or mixture of metals, or metallic ſubſtances, that can be caſt, rolled, drawn, or preſſed into the form I wiſh, and the purpoſe requires; but, as the moſt ſimple form is the moſt eaſily underſtood, I will ſuppoſe the form of the lamp to be round, and the material of which it is to be made, rolled tinned plate. If to bear agitation, I take the ſaid rolled tinned plate, and cut out two round pieces, ſuppoſe three inches diameter, or thereabouts, and a flat piece of a regular width, ſuppoſe one inch, long enough, when the ends are ſoldered together, to form a round of ſuch ſize as will fit and ſolder to the two round pieces before deſcribed; thoſe I fit and ſolder together, ſo as to be air-tight, to hold the oil, or ſpirits, which are to ſupply the burner or burners, and this I call the reſervoir; and if for a ſolid burner or burners, through which no air-tube paſſes, I make a round hole in one of the round parts, ſufficient to contain the top which I mean to place therein, ſuppoſe one inch and a quarter diameter, or thereabouts, and three eighths of an inch deep in the rim; to make which I cut two pieces, of nearly an equal length or width, ſo that when the

two

two ends of each are ſoldered together, and made round, they will ſcrew or ſqueeze into each other, air-tight; one of which round rims I ſolder, air-tight, in the round hole of the reſervoir, and with the other I form the top; to do which I cut a round piece of tinned plate, of ſuch diameter as will fit and ſolder, air-tight, to the ſaid top rim; in the circle of which I make a hole, wherein to fix the burner tube or tubes, which I make of tinned plate, of any ſize or any ſhape I think proper, and then I ſolder the ſame, air-tight, in the hole or holes made in the top for that purpoſe; part thereof to lead into the reſervoir, and part to ſtand above, at the bottom of which external part or parts I make one or more ſmall hole or holes, through which the oil or ſpirits that fall down the tube or tubes, from the burner or burners, may return again to the wick or wicks; and, as ſuch oil or ſpirits, with which the lamp is charged, are liable to run about and waſte by agitation, I preſerve the ſame by fixing a rim round the ſaid burner or burners, which will prevent the oil or ſpirits eſcaping, and this part I call the preſerver. When all this is done, and I have filled the re-

ſervoir with oil or ſpirits, and properly trimmed the burner tube or tubes, with wick or wicks, and fixed the top to the reſervoir, ſo as to be every way air-tight, except through the burner tube or tubes, I then tin'd* or light the wick or wicks, and, as they continue to burn, the oil or ſpirits, when they get warm, will naturally ſwell; and, as the reſervoir is every way air-tight, and the oil or ſpirits have no other way for expanſion, the liquid will flow ſuperabundantly up the burner tube or tubes, ſo as to overcharge the preſerver; and afterwards, as the oil or ſpirits diminiſh by burning, the air will preſs into the reſervoir, the ſame way, to ſupply the vacancy occaſioned by the diminution of the oil or ſpirits, and ſo retard the oil or ſpirits in riſing to ſupply the burners; to prevent both which inconveniences, I make a ſmall hole through the top, into the reſervoir, that the air may paſs and repaſs, as the ſwelling or ſinking of the oil or ſpirits requires; which hole is ſo ſmall that no more oil or ſpirits can eſcape than the preſerver will

* Compared with the record in the office.

ſecure;

ſecure; and, as the oil or ſpirits are liable to leak, as well through the wick or wicks as the ſmall hole in the preſerver, if by accident it ſhould be laid on one ſide or turned upſide down, it is neceſſary to guard againſt it; to do which I fix a ſmall rim in the top of the preſerver, leading part down the ſame, leaving a ſpace round ſuch ſmall rim, within the preſerver, to contain the oil or ſpirits that may chance to come therein, to which ſmall rim I make another, that will ſcrew or ſqueeze, air-tight, into ſuch ſmall rim, and of ſuch width that, when one edge is ſcrewed or ſqueezed air-tight into ſuch ſmall rim, the other will riſe higher than the top of the burner or burners, ſo that it may be put on and taken off without diſturbing the wick or wicks. I then ſolder a round bit of tin plate thereon, air-tight, and it will then not only ſerve for an extinguiſher occaſionally, but will ſecure any oil or ſpirits which may chance to come into the preſerver by ſuch accident. For making air burner or burners, I make the top or other parts of the lamp upon the foregoing principle, with the following difference; I make a hole in the bottom of the re-

 ſervoir,

ſervoir, ſuppoſe one quarter of an inch diameter, or more, as the burner or burners require, into which I ſolder, air-tight, a round air-tube, the upper part of which is to ſtand in the centre of the top. I then make another tube, that will ſcrew or ſqueeze without ſide of the air-tube, ſo as to render it air-tight, which outſide tube I fix in the centre of the top (as before deſcribed) ſo as to ſcrew or ſqueeze, air-tight, round the air-tube, juſt as the top and reſervoir rims are; round or by the ſide of which outſide tube, (which is beſt in a conical form,) I fix one or more burner tube or tubes, in what form or ſhape I think proper, and ſolder the whole within the top, air-tight, as before deſcribed, taking care to keep the top of the burner tube or tubes at ſuch a diſtance from the conical tube, that the oil or ſpirits which fall from the burner or burners cannot go therein, but be returned to the wick or wicks, through the hole or holes at the bottom of the external part of the burner tube or tubes, within ſide the preſerver, as before deſcribed; when a ſtopper or ſtopple, being put into the top of the conical tube, ſo as to be air-tight, will, with the extin-

guiſher

guiſher before deſcribed, perfectly ſecure any oil or ſpirits that may chance to come therein; and, in order that all lamps made upon this principle may continue to burn in all ſorts of weather, I place or fix them in a lantern, made for that purpoſe, in any form or ſhape I think proper. I can make lamps in any form I think proper upon the ſame principle, but it muſt be obſerved, that the thinner the wick, and the nearer the air is conveyed to the burner or burners, the more brilliant the light will be, but the burner or burners will then want trimming the oftener; but, when motion is not required, that part of the principle of being air-tight is unneceſſary. To make a lamp that will continue to burn without trimming for a long ſpace of time, I make the reſervoir (as I think beſt) of a much ſmaller diameter than depth; which, by means of a ſtopple, or ſtopper, fixed in a hole at the top thereof, (for admitting the oil or ſpirits therein,) is to be made air-tight; or elſe I do not make any hole at the top, but one at the bottom, or lower part of the ſide of the reſervoir, whereby the ſame may be filled, by laying the reſervoir on one ſide, or

upſide

upſide down; to which hole I fix a tube, and, at the end of it from the reſervoir, a ſmall baſon, proportioned to the ſize of the burner I mean to place therein, into which the oil or ſpirits can only paſs upon the ſame principle as a bird-cage water-fountain. When I have filled the reſervoir, and ſet it perpendicular, and the oil and ſpirits have found their juſt medium in the ſmall fountain-baſon, I take a quantity of fine wire, in proportion to the ſize I intend the burner to be, twiſt it together, and turn it into ſuch form that it will ſtand of itſelf in the middle of the fountain-baſon, which I take care to place at ſuch a diſtance from the reſervoir, that the heat of the burner may rarify the oil or ſpirits within the reſervoir, in proportion to its conſumption; I then make the burner hot till the oil or ſpirits take fire, and it will then continue to burn (if defended from any ſudden impulſe of air) ſo long as it is properly ſupplied. In witneſs whereof, &c.

XXII.

XXII. *Specification of the Patent granted to Mr.* WILLIAM ROBERTS, *of High-ſtreet, in the City of Briſtol, Linen-Draper, and Mr.* WILLIAM DIGHT, *of the ſame Place, Painter; for their Invention of running or laying Paint, mixed and prepared with Oil and other Materials, in thin Layers, upon Canvas, Wood, Iron, Stone, or any Subſtance of that Kind, in a Way not yet known and in Practice.*

Dated May 11, 1790.

TO all to whom theſe preſents ſhall come, &c. NOW WE, the ſaid William Roberts and William Dight, in compliance with ſuch condition, in the ſaid letters patent, do hereby declare, that ſuch our invention, and the nature of the ſame, is the running or laying paint, mixed and prepared with oil and other materials, commonly called oil-colours, upon canvas, wood, iron, ſtone, or other ſubſtances, in ſuch a way as to preſerve its tranſparency; and we do hereby farther declare, that the manner in which the ſaid art or invention is to be performed, and which we uſe and obſerve in

in the performance thereof, is as follows; that is to ſay, we prepare the canvas, wood, iron, ſtone, or other ſubſtance, upon which the painting or imitation is intended to be made, with a ground of any colour which we wiſh to be moſt prevalent, or ſhew itſelf moſt; which ground is made with colours prepared in the common way, for hard ſubſtances; and, for ſofter ſubſtances, intended to be uſed as table-covers, or to be folded, and therefore required to be more pliable and elaſtic, with a varniſh made with India rubber or gum elaſtic, diſſolved in ſpirits of wine. After the above ground or coat of colour is dry, or nearly ſo, we vein, paint, or ſpot it, with a pencil, or by drops, agreeable to the pattern or figure we wiſh to imitate or repreſent, or according to our fancy, with colours mixt rather thick with olivar *, or oil varniſh. Immediately before theſe colours are dry, we add any other colours we fancy, made as tranſparent as we can, and mixt up with thin meggellup, a ſubſtance well known to limners, being a mixture of turpentine, gum maſtic, and

* Compared with the record in the office.

linſeed-

linſeed-oil. Whilſt the colours and oil remain wet, we blow them with the breath, or with a pipe from an engine, or pair of bellows, which cauſes them to incorporate; but they ſtill remain tranſparent, or viſible one through the other, which the uſe of a pencil or other hard ſubſtance would prevent their doing, as it would render them opaque. By the above means, the various ſhades and tints of foſſils, ſhells, ſtones, and other things, as fancy directs, are imitated. As ſoon as the above is dry, we varniſh it over with the different ſorts of varniſh, either ſoft or hard, according to the uſe the imitation is intended for; which dry, for common uſes, the whole work is complete; but, if intended to be uſed for chimney-pieces, or ſuch like uſes, then we poliſh and varniſh the work repeatedly, in like manner as is done for coach-pannels, till the work attains ſuch perfection and hardneſs as we think will render it durable. The colours we uſe in the above proceſs are the ſame as are uſed by painters in oil-colours in general, obſerving always to prefer thoſe which, in their own nature, are moſt tranſparent. In witneſs whereof, &c.

XXIII. *Defcription of a Method of preventing Injury to the Health of thofe employed in carding Cotton. In a Letter to the Editors.*

WITH A PLATE.

Rothfay, 18th May, 1795.

THE favourable reception which you gave my paper refpecting cattle-mills has encouraged me to trouble you with the enclofed, which I hope will alfo meet with your approbation.

I am, &c. R. B.

Confidering health to be a material object in every manufacture, I was induced, from my fituation, to devife fome method of preventing the bad effects which attend the carding for coarfe wefts, in that of cotton.

The

The great quantity of films and duſt, which fly off in this operation, are evidently hurtful, and render the conducting it a diſagreeable and dangerous employment. The ſimpleſt remedy for this evil, which occurred to me, was the encloſing the cards, in ſuch a manner (by leaving out thoſe parts only which require conſtant attention) as to keep the flyings from the people. I accordingly put the idea in practice, and now, after conſiderable experience, find it not only to anſwer all my expectations in reſpect to health, but to be attended with profit, by more effectually collecting the flyings, which may be applied to ſome purpoſes with advantage.

Expecting that the hint may be uſeful, I have annexed a ſketch of the encloſure, which, I doubt not, may be improved upon by more able mechanics.

Explanation of the Figure.

(See Plate XI.)

Fig. 1, A B C D, plan of an enclofure for two machines.

E F G H I K L M, the fpace occupied by the machines.

Fig. 2, Section through the line G H.

O P Q R, the enclofure.

S T, the carding-machines, having their feeding and delivering parts without the enclofure.

Fig. 3, An elevation of the fide A C, fhewing the doors, windows, and parts that are opened when the machines require cleaning or repair.

N. B. Cords are conducted, from the pulleys which give motion to the cards, to the men who work the roving billies; by means of which they have it in their power to ftop them at any time, without going into the enclofure.

XXIV.

Fig. 1

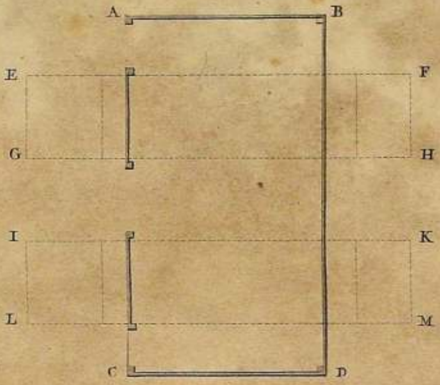


Fig. 2

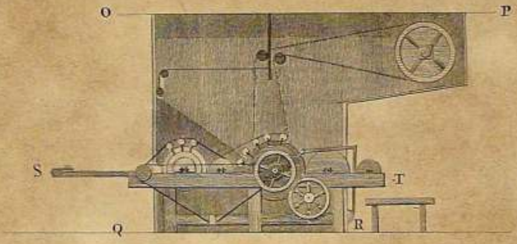
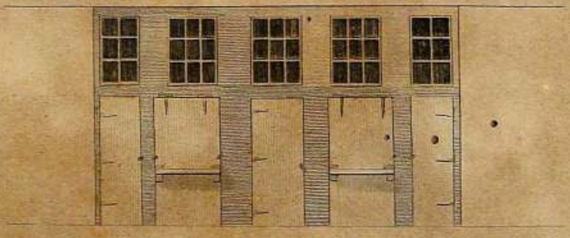


Fig. 3



XXIV. *An Attempt to obtain and preſerve* PRACTICAL STANDARDS, *for adjuſting, in future, the Weights and Meaſures of this Kingdom; by* SAMUEL MORE, *Eſq. Secretary to the Society for the Encouragement of Arts, Manufactures, and Commerce.*

From the TRANSACTIONS of the ſaid SOCIETY.

MANY learned and ingenious perſons have employed themſelves in attempting to diſcover an univerſal ſtandard weights and meaſures, renewable (in caſe its being loſt) in any climate, and under any circumſtances; and ſome papers on this ſubject have been ſubmitted to the public, within theſe few years, by Mr. Hatton (ſee the Tranſactions of the Society, vol. I. p. 239.) and Mr. Whitehurſt; but, after paying every attention to this matter in my power, I am induced, with due deference to ſuch authorities, to conclude, that ſuch a ſtandard may rather be conſidered

ſidered as a thing deſirable than likely to be obtained, at leaſt ſo as to ſerve practically the uſes in common life. I ſhall therefore beg leave to ſubmit my thoughts on this head, conſidering that what may be hereafter ſaid is intended ſolely as an eaſy method of forming and preſerving a ſtandard of weights and meaſures, for the uſe of theſe kingdoms, or any other that may think proper to adopt it; and which, it is preſumed, will anſwer all that is wiſhed for in obtaining a practical ſtandard, for adjuſting, in future, the weights and meaſures of this country.

For this purpoſe I adviſe, that a certain weight be aſſumed, and called a pound; and, to avoid, as much as poſſible, any innovation or confuſion, let this aſſumed weight be adjuſted by the preſent ſtandard pound weight, at his Majeſty's Exchequer, or the Guildhall of London. This weight may be made of braſs, but, as all metals are ſubject to decay and loſs, by corroſion, by the air, by friction, &c. let a piece of agate, or other hard ſtone, be cut into the form of an egg; and, when brought exactly to the weight of the braſs ſtandard, by carefully grinding and poliſhing, let it be

preſerved

preſerved in a proper caſe, lined with ſoft cloth, or velvet, to be reſorted to whenever there may be occaſion. A piece of agate of this form ſeems ſo unlikely to be injured by any means, except by ſuch a degree of violence as may break it, that there can be little doubt of its remaining of the ſame weight for ages; more eſpecially as it will be effectually guarded from the action of the air, and all motion, in its caſe, and never expoſed but on occaſion of comparing the braſs ſtandard with it; which, to prevent error, ſhould be done at ſtated times, as once in twelve months, on a day ſpecifically appointed for the purpoſe, in the preſence of ſuch officers as may be nominated, and with as much form and preciſion as is uſed in the trial of the Pix, to determine the ſtandard of the coin.

I have hitherto only mentioned the pound weight; but it is obvious that all the parts of the pound, as the half, the quarter, the ounce, &c. ſhould be provided for in the ſame manner. Let it be underſtood that the pound, hitherto ſpoken of, is ſuppoſed to be what is generally called the Avoirdupois pound, and divided into ſixteen

ounces,

ounces, each ounce ſubdivided into ſixteen drachms. As this is the weight by which all large commodities are weighed, it does not appear to have been thought neceſſary that weights ſmaller than the half-drachm, or the thirty-ſecond part of the ounce, ſhould be introduced; but, as that weight is nearly equal to thirteen grains and one half, Troy, it may be farther divided, if judged proper, ſo as to weigh ſmall matters, as very fine thread, or other ſuch like valuable commodities, more accurately than is generally practiſed; and, if the drachm is ſubdivided into eight parts, each of them will be equal nearly to three grains and a half, Troy. To avoid confuſion, all weights for this purpoſe, when ſold, ſhould differ in form from the grains uſed as Troy weight, and be called by ſome other name.

As it has been always cuſtomary to have weights of different denominations uſed in this kingdom, and no ſufficient reaſon has appeared to juſtify an alteration in the practice; and as the Avoirdupois weight has been conſtantly uſed for large quantities of goods, and the Troy weight for ſmaller quantities, and the more valuable com-

commodities, let a Troy pound be prepared, as has been already adviſed for the Avoirdupois, with its equal in agate, to be preſerved, and uſed in all caſes as the other. Let this pound be divided, as has been the uſage, for the goldſmith, into ounces, penny-weights, and grains; and, for the apothecary, into ounces, drachms, ſcruples, and grains; each of them being adjuſted in the moſt accurate manner poſſible, ſo that all the aliquot parts ſhall bear a due proportion to the whole: and to this the moſt ſcrupulous exactneſs is neceſſary, for, from a defect in this inſtance, moſt of the complaints on the want of a due ſtandard ſeem to have originated.

Having thus, in as conciſe a manner as poſſible, ſubmitted my opinion on an eaſy way of obtaining a practical ſtandard for weights, which may at all times be reſorted to, without danger of its ſuffering any diminution in bulk or weight; I ſhall only farther obſerve, that it may be adviſable to have three ſets of theſe agate ſtandards, to be kept at different places, whereby the danger of the loſs of ſuch ſtandards, by fire or otherwiſe, will be effectually guarded againſt.

I ſhall now proceed to ſuggeſt a method, whereby meaſures of length, and conſequently meaſures of capacity, may be formed from the forementioned ſtandards of weight.

It has been univerſally allowed, that the weight of a cubic foot of clear ſoft river-water is equal to ſixty-two pounds and a half, Avoirdupois weight, or one thouſand ounces; and the moſt celebrated authors have thence calculated and publiſhed the hydroſtatic weight of many ſolids: this appears a ſingular circumſtance, and not likely to have happened by chance, but to have been accompliſhed by means that have not been tranſmitted to us. As this, however, if not ſtrictly true, is not far from the truth, I propoſe forming a meaſure on its principle, to be called the Britiſh foot.

Let, therefore, a hollow cube be made of braſs, of ſuch dimenſion as to exactly contain a quantity of ſoft river-water, equal in weight to ſixty-two pounds and a half, or one thouſand ounces, of the above deſcribed Avoirdupois weight. To arrive at as great a degree of preciſion as poſſible, it may be proper to fix ſome ſtandard of heat, at

which,

which, it is intended, the above quantity of water may be reckoned to fill the cube, and this may be at ſixty degrees of Fahrenheit's thermometer.

It will probably be attended with conſiderable difficulty and expence to procure ſuch a veſſel, but, as it is to be preſumed that workmen may be found to execute it, the expence ſhould be no object; for, ſuch weights as are above deſcribed, agreeing with ſuch a veſſel of water, will give a preciſion to hydroſtatic experiments, and determine the relative weight of ſolids to water, more clearly than is now eaſily done, and, at the ſame time, form a decided ſtandard of meaſure.

Having, therefore, procured ſuch a cubic veſſel, the length of one ſide of it is to conſtitute the Britiſh foot, which is to be divided into twelve inches, and thoſe inches into ſmaller parts, as uſual. It is hardly neceſſary to ſay that, ſuch a meaſure of length being obtained, it will be proper that ſtandards be made, in the manner formerly executed by Mr. Bird; or, if any better have been diſcovered, that ſuch be adopted.

From the ſtandard Britiſh foot are to be calculated all meaſures of length, as yards, furlongs,

miles, &c. It will, therefore, be highly proper to have fome of thefe ftandards moft carefully executed, and preferved, as has been already mentioned concerning the ftandard-weights; and, that thofe in ufe be alfo from time to time examined, and compared with fome one kept for that purpofe; fo that, fhould any error arife, it may not long fubfift, and confequently not become of magnitude fufficient to do any injury.

From this meafure of length, it is eafy to afcertain all meafures of capacity; and, if the feveral old Acts of Parliament which are ftill in force be carefully attended to, and the perfons employed to authenticate the meafures by ftamps are fully informed of the neceffity of the feveral meafures being of the forms and dimenfions prefcribed by thofe laws, it is prefumed a general meafure and weight, fufficiently accurate for all practical purpofes, may be eafily made and introduced throughout the kingdom; and of what advantage this would be need not be mentioned.

At the beginning of this paper, it was obferved, that I intended merely to confine myfelf to a practical method of obtaining a weight which might

ferve

ſerve as a ſtandard for this kingdom. All theory, and all mathematical calculations, have therefore been ſedulouſly avoided; and I have, through the whole, endeavoured to form the new ſtandard on the baſis of the old one, thereby avoiding, as much as poſſible, all innovation; and, although it has been frequently propoſed to divide all weights and meaſures decimally, which certainly in ſome caſes would have its advantages, yet, when it is conſidered how much the generality of the people would be perplexed and confounded, ſhould ſuch a change be adopted, and reflecting how well the trade and commerce of the kingdom may be carried on by conforming to the ancient mode, I have adviſed the adjuſting the weights and meaſures of this country by the means above-mentioned, which, as appears to me, may be eaſily put in practice with ſufficient accuracy for all the common purpoſes of life.

XXV. *Deſcription of a Fire-Engine on a new Conſtruction ; by* Mr. BENJAMIN DEARBORN.

WITH A PLATE.

From the MEMOIRS of the AMERICAN ACADEMY of ARTS and SCIENCES.

HAVING conſtructed a model of a portable fire-engine, on the ſame principle as the pump-engine formerly deſcribed *, I think proper to ſend the following deſcription of it.

A B and C D (Plate XII. Fig 1.) are the edges of two planks, confined together by four bolts. *a b* and *c d* are two cylindrical barrels ; in each of theſe barrels, a piſton, with a valve, is faſtened to the ſpear *e*, and is moved up and down alternately, by the motion of the arms E E. Under each barrel a hole is made, through the plank A B, and covered with a valve. The arms E E are hung on the common centre *f*: arms parallel to theſe are on the oppoſite ſide. *g g* are the ends

* See our laſt number page 119.

of

of handles which are faſtened acroſs the ends of the arms. A bolt at *h* goes acroſs from arm to arm; to this bolt the piece *i k* is faſtened, and plays upon it; the lower end of this piece is faſtened to the top of the ſpear *e*. G *l f* is a ſtandard to ſupport the arms; another anſwers to it on the oppoſite ſide, and both are notched into the edges of the planks, where they are ſufficiently ſecured, by one bolt going through them at *l*, which has a nut or forelock on the oppoſite ſide. H I, H I, are ſquare braces, which anſwer the purpoſe of ducts, through which the water aſcends from the barrels, paſſing through the plank at *m*. K L, K L, are irons in the form of a ſtaple, to confine the braces; the lower ends of theſe irons meet, and are ſecured with one bolt, going through them and M N *n o*, which is a piece going up through a mortice in the centre of the planks. This piece is ſquare, from the lower end upward, as high as the top of the braces; from them to the top it is cylindrical, the upper end being bored hollow, far enough down to communicate with the braces. O P is an iron ring, going round the tube, having two ſhanks going up through the

the head, with ſcrews on the top at *p q*. *r s* is a ferrule, nailed round the tube. The head, and pipe, are ſo nearly ſimilar to thoſe of the pump-engine that they need no farther deſcription.

Fig. 2. is the ſame engine; the arms and ſtandards being taken off, to give a more intelligible deſcription of the mode of ſecuring the braces; which is effectually done by one wedge, driven into the mortice *a*, under the upper plank. *b* is a hole for the bolt to paſs through, which ſecures the ſtandards. In this figure a ſide view of the head is given, with the pipe in a perpendicular direction.

The work is confined within a box ſet on wheels, as is uſual. The whole is made of wood, except the ſpears of the pumps, and a few bolts, &c. Engines on this conſtruction may be made in any place where a common pump can; the inſide work will not be more than one quarter the coſt of thoſe on the uſual conſtruction; and the labour of working them will (as I conceive) be much leſs than in the others; theſe conſiderations may perhaps recommend them to ſome attention.

XXVI.

Vol. III Pl. XII

Fig. 1

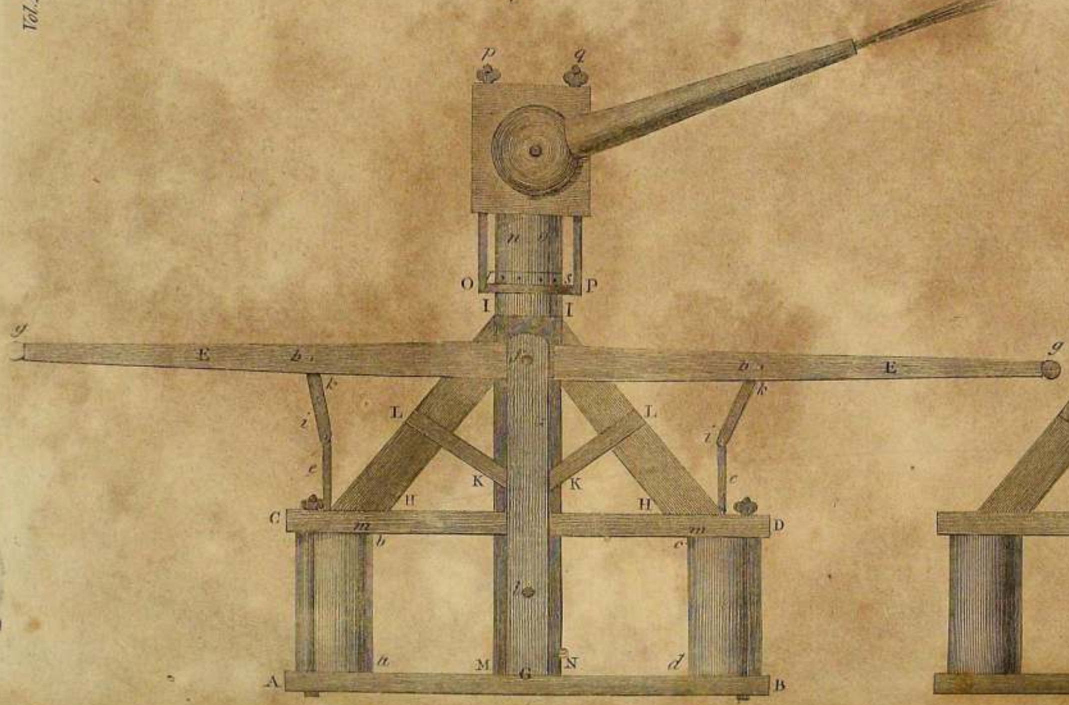
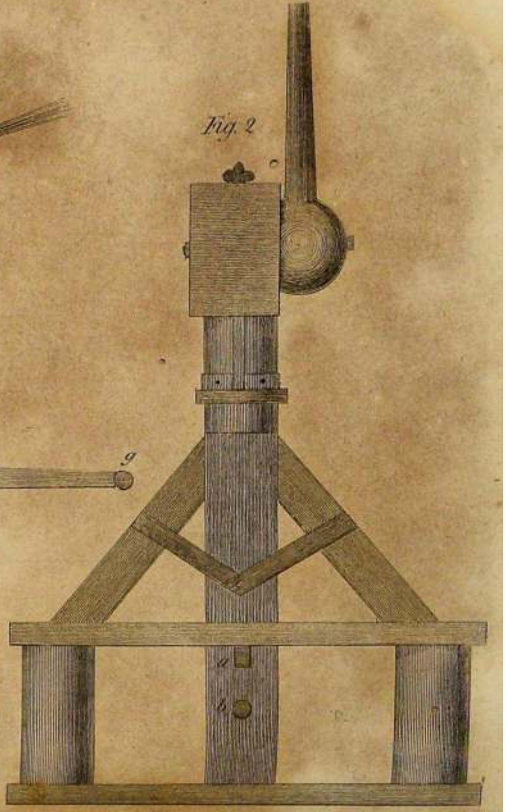


Fig. 2



XXVI. *Experiments and Obſervations on the Diſſolution of Metals in Acids, and their Precipitations; with an Account of a new compound Acid Menſtruum, uſeful in ſome technical Operations of parting Metals.* By JAMES KEIR, *Eſq. F. R. S.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

IN the following paper, I intend to relate two ſets of experiments; *one*, ſhewing the effects of *compounding the vitriolic and nitrous acids in diſſolving metals*; and *the other*, deſcribing ſome curious *appearances which occur in the precipitation of ſilver from its ſolution* * *in nitrous acid by iron, and by*

* The Engliſh word *ſolution* has two ſignifications in chemiſtry; one, expreſſive of the act of diſſolving, as when we ſay,

by some other substances. In a subsequent paper I hope to continue the subject of metallic dissolution, and precipitation, first, by adding some *experiments on the quantities and kinds of gas* produced by dissolving different metals in different acids, under various circumstances; secondly, by submitting certain *general propositions*, which seem deducible from the facts related; and, lastly, by concluding with some *reflexions* relative to the *theory of metallic dissolution and precipitation.*

say, that "solution is a chemical operation;" and the other, denoting the substance dissolved in its solvent, as "a solution "of silver in nitrous acid." The French language is equally equivocal, as the word "*dissolution*" is used in both the above-mentioned senses. In treating on this subject, in which both meanings were very frequently required, sometimes in the same sentence, I could not but be sensible of confusion in the style, and I have therefore confined the word *solution* to express the substance dissolved together with its solvent, and the word *dissolution* to denote the act of dissolving.

PART

PART I.

On the effects of compounding the vitriolic and nitrous Acids, under various Circumſtances, upon the Diſſolution of Metals.

SECTION I.

On the Mixture of Oil of Vitriol and Nitre.

1. The properties of the ſeveral acids, in their ſeparate ſtates, have been inveſtigated with conſiderable induſtry and ſucceſs; and thoſe of one compound, *aqua regis*, are well known, on account of its frequent uſe in diſſolving gold: yet, not only various other combinations of different acids remain to be examined, but alſo the change of properties to which theſe mixed acids are ſubject, from the difference of circumſtances, eſpecially thoſe of *concentration*, *temperature*, and of that quality which is called, properly or improperly, *phlogiſtication*, are ſubjects ſtill open for enquiry.

 2. As

2. As I ſhall have frequent occaſion to ſpeak of the *phlogiſtication* and *dephlogiſtication* of acids, I wiſh to premiſe that, by theſe terms, I mean only certain ſtates or qualities of thoſe bodies, but without any theoretical reference. Thus vitriolic acid may be ſaid to be phlogiſticated by addition of ſulphur, or other inflammable matter, by which it is converted into ſulphureous acid, without determining whether this change be cauſed by the addition of the ſuppoſed principle phlogiſton, as one ſet of philoſophers believe, or by the action of the added inflammable ſubſtance, in drawing from the acid a portion of its aërial principle, by which the ſulphur, its other element, is made to predominate, as others have lately maintained. It were much to be wiſhed that we had words totally unconnected with theory; that chemiſts who differ from each other, in ſome ſpeculative points, may yet ſpeak the ſame language, and may relate their facts and obſervations, without having our attention continually drawn aſide, from theſe to the different modes of explanation which have been

imagined.

imagined. But, at preſent we have only the choice of terms, between words derived from the antient theory, and thoſe which have been lately propoſed by the oppoſers of that theory. In this dilemma I have preferred the uſe of the former, not that I wiſh to ſhew any predilection to either theory, but becauſe that ſyſtem, having long been generally adopted, is underſtood by all parties; and principally becauſe, by uſing the words of the old theory, I am at liberty to define them, and to give ſignifications expreſſive merely of facts, and of the actual ſtate of bodies; whereas, the language and theory of the antiphlogiſtic chemiſts being interwoven and adapted to each other, the former cannot be diveſted of its theoretical reference, and therefore ſeems inapplicable to the mere expoſition of facts, but ought to be reſerved ſolely for the explanation of the doctrines from which this language is derived. Thus, by the definition which I have mentioned of *phlogiſtication*, this word expreſſes not the preſence or exiſtence of an hypothetical principle of inflammability, but a certain well-known quality of acids and of other bodies, communicated to them

by

by the addition of many actual inflammable ſubſtances. Thus nitrous acid acquires a phlogiſticated quality by addition of a little ſpirit of wine, or by diſtillation with any inflammable ſubſtance.

3. No two ſubſtances are more frequently in the hands of chemiſts and artiſts than *vitriolic acid* and *nitre*; yet I have found, that a mere mixture of theſe, when much concentrated, poſſeſſes properties which neither the vitriolic acid nor the nitrous, of the ſame degree of concentration, have ſingly, and which could not eaſily be deduced, *à priori*, by reaſoning from our preſent knowledge of the theory of chemiſtry.

4. Having found, by ſome previous trials, that a mixture compoſed of nitre diſſolved in oil of vitriol was capable of diſſolving ſilver eaſily, and copiouſly, while it did not affect copper, iron, lead, regulus of cobalt, gold, and platina, I conceived that it might be uſeful in ſome caſes of the parting of ſilver from copper, and the other metals above-mentioned; and, having alſo obſerved, that the diſſolving powers of the mixture of vitriolic and nitrous acids varied greatly,

greatly, in different degrees of concentration and phlogiſtication, I thought that an inveſtigation of theſe effects might be a ſubject fit for philoſophical chemiſtry, and might tend to illuſtrate the theory of the diſſolution of metals in acids. With theſe views I made the following experiments.

5. I put into a long-necked retort, the contents of which, including the neck, were 1400 grain-meaſures, 100 grain-meaſures of oil of vitriol, of the uſual denſity at which it is prepared in England, that is, whoſe ſpecific gravity is to that of water as 1,844 to 1, and 100 grains of pure and clean nitre, which was then diſſolved in the acid by the heat of a water-bath. To this mixture 100 grains of ſtandard ſilver were added; the retort was ſet in a water-bath, in which the water was made to boil, and the pneumatic apparatus was applied, to catch any air or gas which might be extricated.

The ſilver began to diſſolve, and the ſolution became of a purple or violet colour. No air was thrown into the inverted jar, excepting a little of the common air of the retort, by means of the expanſion

expansion which it suffered from the heat of the water-bath, and from some nitrous fumes which appeared in the retort, and which, having afterwards condensed, occasioned the water to rise along the neck of the retort, and mix with the solution. The remaining silver was then separated and weighed, and it was found that 39 grains had been dissolved; but probably more would have been dissolved if the operation had not been interrupted by the water rushing into the retort.

6. In the same apparatus 200 grains of standard silver were added to a mixture of 100 grains of nitre previously dissolved in 200 grain-measures of oil of vitriol; and in this solvent 92 grains of the silver were dissolved, without any production of air or gas. The solution, which was of a violet colour, having been poured out of the retort while warm, (for, with so large a proportion of nitre, such mixtures, especially after having dissolved silver, are apt to congeal with small degrees of cold,) in order to separate the undissolved silver from it, and having been returned into the retort without this silver, I poured 200 grains of water into

into the retort, upon which a ſtrong effervefcence took place between the folution and the water, and 3100 grain-meaſures of nitrous gas were thrown into the inverted jar. Upon pouring 200 grains more of water into the retort, 600 grain-meaſures of the ſame gas were expelled. Farther additions of water yielded no more gas; neither did the ſilver, when afterwards added to this diluted ſolution, give any ſenſible effervefcence, or ſuffer a greater loſs of weight than two grains.

7. In the ſame apparatus, 100 grains of ſtandard ſilver were expoſed to a mixture of 30 grains of nitre diſſolved in 200 grain-meaſures of oil of vitriol; and, in this operation, 80 grains of ſilver were diſſolved, while, at the ſame time, 4500 grain-meaſures of nitrous gas were thrown into the inverted jar. When the undiſſolved ſilver was removed, 200 grains of water were added to the ſolution, which was of a violet colour, and, upon the mixture of the two fluids, an effervefcence happened; but only a few bubbles of nitrous gas were then expelled.

 8. In

8. In the ſame apparatus, 100 grains of ſtandard ſilver were expoſed to a mixture of 200 grain-meaſures of oil of vitriol, 200 grains of nitre, and 200 grains of water; and, in this operation, 20 grains of the ſilver were diſſolved, without any ſenſible emiſſion of air or gas.

9. In theſe experiments, the copper contained in the ſtandard ſilver gave a reddiſh colour to the ſaline maſs which was formed in the ſolution, and ſeemed to be a calx of copper interſperſed through the ſalt of ſilver. I perceived no other difference between the effects of pure and ſtandard ſilver diſſolved in this acid.

10. I then expoſed *tin* to the ſame mixture of oil of vitriol and nitre, in the ſame apparatus, and in the ſame circumſtances; taking care always to add more metal than could be diſſolved, that, by weighing the remainder, the quantity capable of being diſſolved might be found, as I had done with the experiments on ſilver; and the reſults were as follow.

11. No tin was diſſolved, or calcined, by a mixture in the proportion of 200 grain-meaſures of

of oil of vitriol to 200 grains of nitre; nor by another mixture, in the proportion of 200 grain-meaſures of oil of vitriol to 150 grains of nitre, and conſequently no gas was produced in either inſtance.

12. With a mixture in the proportion of 200 grain-meaſures of oil of vitriol to 100 grains of nitre, the tin began ſoon to be acted on, and to be diffuſed through the liquor; but no extrication of gas appeared until the digeſtion had been continued two hours in boiling water; then it took place, and gave a frothy appearance to the mixture, which was of an opaque white colour, from the powder of tin diffuſed among it. In this experiment, the quantity of tin thus calcined was 73 grains, and the quantity of nitrous gas extricated, during this action on the tin, was 8500 grain-meaſures. Then, upon pouring 200 grains of water into the retort, a freſh effervefcence took place between the water and the white opaque maſs, and 4600 grain-meaſures of nitrous gas were thrown into the inverted receiver.

13. With a mixture in the proportion of 100 grain-meaſures of oil of vitriol to 30 grains of

 nitre,

nitre, 30 grains of tin were diſſolved, or calcined, and the nitrous gas, which began to be extricated much ſooner than in the laſt-mentioned experiment, with a larger proportion of nitre, amounted to 6300 grain-meaſures. Water, added to this ſolution of tin, did not produce any effervescence.

14. With a mixture, in the proportion of 200 grain-meaſures of oil of vitriol to 200 grains of nitre and 200 grains of water, 133 grains of tin were acted on with an effervescence, which took place violently, and produced 6500 grain-meaſures of nitrous gas.

15. The ſeveral mixtures above-mentioned, in different proportions of nitre and oil of vitriol, did, by the help of the heat of the water-bath, calcine *mercury* into a white or greyiſh powder. *Nickel* was alſo partly calcined, and partly diſſolved, by theſe mixtures. I did not perceive that any other metal was affected by them, excepting that the ſurfaces of ſome of them were tarniſhed.

16. Theſe mixtures of oil of vitriol and nitre were apt to congeal by cold, thoſe eſpecially which

which had a large proportion of nitre. Thus, a mixture of 1000 grain-meaſures of oil of vitriol and 480 grains of nitre, after having kept fluid ſeveral days, in a phial not ſo accurately ſtopped as to prevent altogether the eſcape of ſome white fumes, congealed at the temperature of 55° of Fahrenheit's thermometer; whereas, ſome of the ſame liquid, having been mixed with equal parts of oil of vitriol, did not congeal with a leſs cold than 45°. The congelation is promoted by expoſure to air, by which white fumes riſe, and moiſture may be abſorbed, or by any other mode of ſlight dilution with water.

17. Dilution of this compound acid, with more or leſs water, alters conſiderably its properties with regard to its action on metals. Thus, it has been obſerved, that in its concentrated ſtate it does not act on *iron*; but, by adding water, it acquires a power of acting on that metal, and with different effect, according to the proportion of the water added. Thus, by adding to two meaſures of the compound acid one meaſure of water, the liquor is rendered capable

of

of calcining iron, and forming with it a white powder, but without effervescence: with an equal measure of water effervescence was produced: with a larger proportion of water the iron gave also a brown colour to the liquor, such as phlogisticated nitrous acid acquires from iron, or communicates to a solution of martial vitriol in water.

18. Dilution with water also renders this compound acid capable of dissolving *copper* and *zinc*, and probably those other metals which are subject to the action of the dilute vitriolic or nitrous acids.

SECTION II.

An Account of a new Process for separating Silver from Copper.

19. The properties of this liquor, in dissolving silver easily, without acting on copper, have rendered it capable of a very useful application in the arts. Among the manufactures at Birmingham, that of making vessels of silver plated on

copper is a very confiderable one. In cutting out the rolled plated metal into pieces of the required forms and fizes, there are many fhreds, or *fcraps*, as they are called, unfit for any purpofe but the recovery of the metals by feparating them from each other. The eafieft and moft œconomical method of parting thefe two metals, fo as not to lofe either of them, is an object of fome confequence to the manufacturers. For this purpofe two modes were practifed; one, by melting the whole of the mixed metals with lead, and feparating them by eliquation, and tefting; and the fecond, by diffolving both metals in oil of vitriol, with the help of heat, and by feparating the vitriol of copper, (by diffolving it in water,) from the vitriol of filver, which is afterwards to be reduced and purified. In the firft of thefe methods, there is a confiderable wafte of lead and copper; and, in the fecond, the quantity of vitriolic acid employed is very great, as much more is diffipated, in the form of volatile vitriolic or fulphureous acid, than remains in the compofition of the two vitriols.

Some years ago, I communicated to an artist the method of effecting the separation of silver and copper by means of the above-mentioned compound of vitriolic acid and nitre; and, as I am informed that it is now commonly practised by the manufacturers in Birmingham, I have no doubt but it is much more œconomical, and it is certainly much more easily executed, than any of the other methods; for, nothing more is required than to put the pieces of plated metal into an earthen glazed pan; to pour upon them some of the acid liquor, which may be in the proportion of eight or ten pounds of oil of vitriol to one pound of nitre; to stir them about, that the surfaces may be frequently exposed to fresh liquor; and to assist the action by a gentle heat, from 100 to 200° of Fahrenheit's scale. When the liquor is nearly saturated, the silver is to be precipitated from it by common salt, which forms a *luna cornea*, easily reducible by melting it in a crucible with a sufficient quantity of potash; and, lastly, by refining the melted silver, if necessary, with a little nitre thrown upon it. In this manner the silver

ver will be obtained ſufficiently pure, and the copper will remain unchanged. Otherwiſe, the ſilver may be precipitated in its metallic ſtate, by adding to the ſolution of ſilver a few of the pieces of copper, and a ſufficient quantity of water to enable the liquor to act upon the copper.

The property, which this acid mixture poſſeſſes, of diſſolving ſilver with great facility, and in conſiderable quantity, will probably render it an uſeful menſtruum in the ſeparation of ſilver from other metals; and, as the alchemiſts have diſtinguiſhed the peculiar ſolvent of gold under the title of *aqua regis*, a name ſufficiently diſtinctive though founded on a fanciful alluſion, ſo if they had been acquainted with the properties of this compound, they would probably have beſtowed on it the appellation of *aqua reginæ*.

TO BE CONTINUED IN OUR NEXT.

XXVII. *Conclusion of Mr.* Rinman's *Experiments on the Means of Improving the Vessels used in Cooking.*

(from p. 144.)

Experiment II. I, at different times, added to the mixture made ufe of in the firft experiment (which mixture I fhall call No. I.), the following fubftances, in various proportions, viz. potafh, borax, fixed arfenic, liquor of flints, muriated lime, common falt, minium, glafs of bifmuth, fmalt, and manganefe; every one of thefe fubftances had the effect of haftening the fufion, to a certain degree; but feveral inconveniences attended their ufe, fuch as, rendering the enamel full of bubbles, unequal on its furface, or lefs durable in wear.

Experiment III. I mixed with No. I. an equal quantity of what is called fufible glafs, (*vitrum fufibile,*) compofed of parts of lime, four of fluor fpar, two of quartz reduced into a fine powder, and one tenth of a part of manganefe; the whole having been calcined, and ground with water, in the

the manner colours are ground, I ſpread it on the veſſel with a bruſh. This mixture ran pretty well upon the copper in the coal fire; it alſo attached itſelf very ſtrongly to it, and produced an enamel which was firm and hard, and ſeemed likely to bear wear; but it was of a dark grey colour, and without any brilliancy. The mixture did not melt more readily in the eſſaying furnace.

Two parts of No. I. with one part of the fuſible glaſs, and a quarter of a part of manganeſe, had nearly the ſame effect. This laſt mixture, indeed, was rather more eaſily melted, but it had darker colour.

Experiment IV. In order to try whether theſe mixtures would ſucceed better if the ingredients were previouſly united by fuſion, I melted together, in a crucible, ſix parts of No. I. with one half a part of borax; this mixture, by the help of the bellows, became as fluid as water in the ſpace of four minutes. I poured it into a mortar, and I had a very white ſolid glaſs, the ſurface of which was a little dull, or ſemi-tranſparent. This glaſs, or enamel, when ground very fine with water, might be very eaſily applied upon copper,

by means of a bruſh, or it might be made to run over it. It melted very readily, in the ſpace of a minute, in a ſtrong heat in an eſſaying furnace, forming an even and ſmooth enamel, which bore very well to have any thing boiled in it, and alſo bore alternate changes from heat to cold; but, on account of the borax it contained, it was not capable of reſiſting, for any length of time, the action of acids, eſpecially that of the mineral ones.

Experiment V. No. I. melted with one ſixth of a part of cobalt, produced an opaque glaſs, or enamel, of a dark blue colour; this glaſs, which was ground with water, and then extended upon the copper, was more eaſily melted in the aſſaying furnace than the former. The enamel was firm, even, and ſolid; but, after ſome time, it became of a black colour, though it was at firſt of a fine blue. It did not thoroughly reſiſt the action of acids.

Experiment VI. Eight parts of No. I. with one half of a part of borax, one quarter of a part of nitre, and half a part of manganeſe, were melted, in the ſpace of ten minutes, into a brown liver-coloured glaſs; which, in the aſſaying furnace, pro-

produced upon the copper veffel a black enamel, which had a dull furface. In other refpects it was firm, even, and hard; but it did not fufficiently cover the veffel by a fingle application, nor was it capable of refifting the action of acids

Experiment VII. One part of the brown glafs mentioned in the laft experiment, with three parts of No. I. became, in the effaying furnace with a red heat, almoft as fluid as the laft, and had an even and fmooth furface; but it was of a dark colour, and had not any brilliancy. It was not fenfibly acted upon by vitriolic acid.

Experiment VIII. With refpect to the enamel, obtained by that compofition for glafs, called fufible glafs, which is defcribed in the third experiment, I made fome trials to make it run more eafily, by fome mixture of a lefs price. For that purpofe, I took two parts of the fufible glafs, which I mixed thoroughly with one part of glafs of lead, or of minium; this mixture, put into a crucible, and expofed to a fire kept up by a pair of bellows for a quarter of an hour, melted into a fluid yellow glafs, which however appeared, in certain parts, of an unequal texture, and not com-

pletely

pletely melted. This glass, having been poured out of the crucible while fluid, was powdered, ground with water, and spread upon the copper. It could not be made to run in an assaying furnace; and, in a stronger heat, excited by means of a pair of bellows, it would not run so as to form an enamel, until the copper itself also began to melt. Upon iron it produced a hard enamel, which was smooth, and free from bubbles.

Experiment IX. Four parts of No. I. mixed with one half of a part of litharge, were melted in a crucible, with the help of the bellows, in five minutes, so as to become as fluid as water. This mixture, during the fusion, emitted a smell of sulphureous acid, and formed an opaque glass, of a straw colour; which, after being ground, as usual, and spread upon a copper vessel, produced an enamel which covered the vessel very evenly, and was without bubbles. It was likewise almost the hardest of all; but could not be melted in the assaying furnace, requiring a stronger fire, kept up by the bellows. It preserved its straw colour, but without any lustre, and resisted the action of acids better than the common glazing of the potters.

Ex-

Experiment X. The mixture called by the potters *white lead*, (which ferves for the bafis of their glazing, and which, for a white opaque glazing, is compofed of four parts of lead and one part of tin,) after being reduced to afhes by calcination, and melted with falt, was fpread upon a copper veffel. It ran very quickly in the affaying furnace; but did not cover the veffel equally, running together into unequal ill-fhaped maffes.

Experiment XI. To remedy the inconveniences attending on the *white lead* juft fpoken of, either in its application to the veffel or in its fufion, I mixed with it gypfum, and fluor fpar, equal quantities of all three. This mixture, after being calcined, melted in five minutes, with the affiftance of a pair of bellows, into a very white, hard, and opaque enamel, which was very eafily poured out of the crucible. This enamel, treated like the others, ran very freely, equally, and without bubbles, by the heat of the affaying furnace. It was alfo pretty hard and ftrong, but without any luftre, and had green and yellow fpots, occafioned by the acids of the gypfum and fluor

fluor ſpar, which had acted upon the copper during the fuſion of the enamel. It, however, bore melting two or three times, and then appeared of a whiter colour; it was but very little affected by other acids.

Experiment XII. Equal parts of fluor ſpar, of gypſum, of litharge, and of pure flint glaſs, powdered and mixed together, melted in five minutes, by the help of a pair of bellows, and produced a white and hard glaſs, very like that of the laſt experiment, (No. XI.) but rather harder. After being applied on the veſſel, in the uſual manner, it formed, with the greateſt heat of an aſſaying furnace, an enamel of a yellowiſh white colour, firm and hard, but without luſtre. In order to avoid the formation of bubbles, care was taken (as ought always to be done in enamelling) to remove the veſſel from the fire as ſoon as it had acquired a brilliant appearance therein, or as ſoon as the enamel was completely melted.

Experiment XIII. Twelve parts of glaſs of lead, or of litharge, with eight parts of flint glaſs, and two of flowers of zinc, were melted, in the ſpace of ſeven minutes, into a clear yellow glaſs, which

when

hwen used for enamelling, was disposed to form bubbles; but, by continuing the heat for a longer time, the bubbles were dispersed, and I obtained a pretty good enamel, of a yellow-brown colour with a greenish cast, very hard and firm. It resisted the action of the vegetable acids, like the enamels already spoken of, but it was a little attacked by the mineral acids.

Experiment XIV. I powdered and mixed together five parts of fluor spar, five parts of gypsum, two parts of minium, one half of a part of borax, two parts of flint glass, one half of a part of calx of tin, and only one twenty-fifth of a part of calx of cobalt. This mixture was melted in a crucible in six minutes, by help of the bellows, and produced an opaque glass of a pearl colour, a little inclining to blue, on account of the calx of cobalt. It was pretty hard, and, after being ground with water, in the usual way, it became of a very good consistence, so as to be very fit for spreading over vessels, to which it adhered very strongly. If any bubbles formed on the vessel, during its drying, they might be rubbed down with the finger, and the whole surface ren-

dered ſmooth and even. After being warmed, and gradually heated, it was put into an aſſaying furnace made very hot with birch charcoal, which had been juſt kindled under the muffle. After a minute it melted, and began to appear brilliant; ſo that I found it neceſſary to take out the veſſel very quickly, which was already very evenly coated with a thick, and ſufficiently hard, enamel, the ſurface of which, however, had no brilliancy.

The colour remained always inclining to green, becauſe the copper had been a little attacked by the acids of the gypſum and fluor ſpar, during the fuſion; but, in other reſpects, this enamel was very firm, was very little hurt by ſlight blows, and bore very well ſudden changes of heat and cold. Weak acids had no action upon it, but I have ſome reaſon to think that it would, in length of time, have been acted upon, to a certain degree, by vitriolic acid. Its colour, except the forementioned ſhade of green, was white, with a dull, and rather changeable, ſurface.

The calx of cobalt which I have juſt mentioned, and which I made uſe of merely with the intention of obtaining a fine colour, was prepared by

ſaturating

ſaturating a ſolution of cobalt in aqua fortis with common ſalt, and evaporating to dryneſs; by which means I obtained a fine roſe-coloured calx. A very ſmall quantity of this calx, when mixed with any fuſible glaſs, gives it a beautiful blue colour.

Experiment XV. A mixture of eight parts of fluor ſpar, eight parts of gypſum, one part and a half of minium, and only the hundred and twenty-fifth of a part of calx of cobalt, put into a crucible, and urged with a pair of bellows, melted in the ſpace of five minutes into a light-blue glaſs, which, uſed as enamel, was ſimilar to the preceding, No. XIV. but it was rather more ſlow in melting.

Almoſt all the mixtures which have been already mentioned, as enamels for copper, may be applied upon kitchen utenſils, with more or leſs advantage, for the purpoſe of preventing ruſt, or the effects of acids; but, as all theſe enamels, the baſis of which is gypſum and fluor ſpar, have a dull appearance to the eye, a brilliant enamel, which is eaſily fuſed, and which was prepared expreſsly for iron, (its compoſition will be given hereafter,) may be alſo made uſe of upon copper. It has

only the inconvenience of not refifting the action of acids fo well as the others.

The circumftance before fpoken of, namely, that the acids, belonging to the above-mentioned fpecies of ftones, act upon the furface of the copper veffels, during the fufion of the enamel, occafions very often a colour we do not expect; this colour is fometimes partly green and partly red, or fpotted. But, by means of this fpecies of folution, the enamel attaches itfelf more firmly to the copper, and penetrates it in a certain degree, fo that it cannot be made to feparate from it without great difficulty, even though we break the veffel for that purpofe.

Mr. Jufti, in the fecond volume of his Collection of Chymical Tracts, (p. 142,) has alfo propofed making trial of an enamel which fhould attach itfelf firmly to copper; for that purpofe he recommends that we fhould begin by calcining a mixture of four parts of pure potafh and one part of fulphur; to which is to be added a fufficient quantity of vinegar, or water, to form a thin pafte. When this pafte has been ground very fine, it is to be equally and evenly fpread

over

over the copper veſſel, which, however, is to be afterwards coated with a ſtill ſtronger glazing or enamel, compoſed of five parts of quartz finely powdered, two parts of calcined potaſh, and one part of glaſs of lead. If he had himſelf experienced the difficulty of applying, and fixing upon the veſſel, ſuch an enamel as that he deſcribes, he certainly never would have propoſed it.

Of the various ſpecies of enamel which I have deſcribed in the courſe of theſe experiments, the leaſt expenſive are No. I. No. III. and No. IX. but they are alſo thoſe which require the greateſt heat. On the other hand, No. IV. No. V. and, above all, No. XIV. may be recommended as the moſt eaſy of fuſion, and, at the ſame time, very durable when uſed for coating veſſels in which victuals are to be dreſſed, which is here the principal object, and is of far greater importance than the brilliant appearance reſulting from the enamel generally uſed by artiſts, which however may be employed, as I have already ſaid, when the ſaving of expence is not regarded.

Of the Manner of enamelling Iron Veſſels.

It has been generally ſuppoſed that, of all the metals, iron was the leaſt proper for the purpoſe of being coated with any kind of glaſs or enamel. This is indeed ſo far true, that iron does not well bear the common practice of enamellers, namely, to be put into the fire and taken out again ſeveral times, (which is done that the enamel may be adorned with various colours,) becauſe the ſparks which fly from iron, when it is in a hot fire, detach and carry off the enamel from the parts contiguous to thoſe where the ſparks are formed. On this account, I found that none of the preceding compoſitions could be advantageouſly made uſe of upon iron veſſels, and ſtill more becauſe the acids of the gypſum and fluor ſpar acted upon the metal during the fuſion of the enamel, from which reſulted bubbles and bare ſpots, which intirely ſpoilt the appearance of the work.

The white enamel, which, as I have already ſaid, is to be bought at the ſhops, and which may very well be made uſe of upon copper, has not only the inconvenience of attaching itſelf with difficulty

difficulty to iron veſſels, but it is alſo very much diſpoſed to remain unequal, and full of bubbles; to which may be added, that it is alſo of too high a price. In conſequence of thoſe defects, I made many experiments with other mixtures which attach themſelves to iron, and become hard upon it, without furniſhing any acid which can affect it during their fuſion, and which alſo melt without forming bubbles, and with a leſs degree of heat than that which is neceſſary to produce ſparks from iron.

I think it proper to deſcribe here ſome of thoſe experiments which ſucceeded beſt.

Experiment XVI. I reduced into very fine powder, and ground together, nine parts of minium, ſix parts of flint glaſs, two parts of pure potaſh, two parts of purified nitre, and one part of borax. This mixture was put into a large crucible, which it only half filled; I covered the crucible, ſo that no coals could fall into it, and gradually encreaſed the fire under it. When the efferveſcence had intirely ceaſed, I cauſed the mixture to melt, by uſing the bellows for four or five minutes; by theſe means I obtained a clear and compact

pact glaſs, which I poured out of the crucible upon a piece of marble. Having quenched it in water, and reduced it to a very fine powder in a glaſs mortar, I ground it with water to the conſiſtence of a very thin paſte. I then covered an iron veſſel with it, on both ſides; which, after having dried, and heated by degrees, I put under a muffle well heated in an aſſaying furnace. The enamel melted very readily, (in the ſpace of half a minute,) and with a very brilliant appearance. I immediately withdrew the veſſel, and let it cool: it was found to be intirely coated with a beautiful enamel of a black colour; which colour appeared to be cauſed by a thin layer of calcined iron, which might be ſeen through the tranſparency of the enamel.

A copper veſſel having been covered with the ſame enamel, the fine colour of the copper was viſible through the thin coat of glaſs; and it was as well defended from ruſt, by this coating, as it would have been by an enamel of a ſtronger kind.

Experiment XVII. To hinder the colour of the metal from being ſeen through the coating, I added to the mixture, uſed in the preceding experiment, only one hundredth of a part of the

calx

calx of cobalt defcribed in N° XIV. The whole was melted into a beautiful blue glafs; it was prepared for enamelling, and applied, in the manner before defcribed, upon another iron veffel. The enamel proved to be fmooth, thick, and brilliant, like the preceding, but it covered the veffel more perfectly; it was of a fine blue colour, with fome black fpots in thofe parts where it had been moft thinly applied.

Experiment XVIII. The glafs of N° XVI, reduced into powder, and ground with potters *white-lead*, of which mention has already been made, melted with the fame facility; it produced a very fmooth enamel, of a grey colour, but more firm and hard than the former, and, on account of the addition made to it, of a ftill lefs price.

By mixing with the fame glafs, of N° XVI, a fmall quantity of *crocus martis*, I obtained a very fine enamel, of a dark red colour, not to mention other colours in it ftill more beautiful. The *crocus martis* I ufed in this experiment was prepared from a folution of iron in *aqua regia*, which was evaporated to drynefs, and the matter then edulcorated and calcined.

 Ex-

Experiment XIX. In order to render the fore-mentioned enamel more ſolid, and to give it what is called *body*, I prepared a mixture of ſix parts of quartz, finely powdered, nine parts of minium, five parts of the white calx of Engliſh tin, two parts of potaſh, one part of nitre, half a part of borax, and only one hundredth of a part of calx of cobalt. This mixture was melted, with the precautions already deſcribed, and produced an opaque glaſs of a pearl colour, or very light blue; which, when applied upon an iron veſſel, required, for its fuſion, a heat rather greater than N° XVI, and then melted into an enamel of a light blue colour, but neither ſo even nor ſo brilliant as that. It was, however, very good, and hard, and ſeemed very fit for the purpoſe of coating iron veſſels.

Experiment XX. With the intention of remedying, in ſome meaſure, the ſlow fuſion of the laſt enamel, (which perhaps was owing to the quartz,) I melted together a freſh mixture, of twelve parts of flint-glaſs, eighteen parts of minium, four parts of potaſh, four parts of nitre, two parts of borax, three parts of calx of tin, and one

one eighth of a part of calx of cobalt; obſerving always the uſual precautions. I obtained a glaſs of a light-blue colour, which, after having been ground with water, and ſpread upon ſmall iron baſins, or tea-cups, produced, by means of a briſk fire in an aſſaying furnace, an enamel which was ſmooth and even, and of a pearl colour. The coating was of a proper thickneſs, to obtain which requires a certain degree of dexterity and practice.

An iron veſſel, which had been rather unevenly coated with N° XIX, had a coating of this applied over the other; and acquired, by that means, much more brilliancy.

I alſo tried to paint upon this enamel, with what is called mineral purple (*purpura mineralis*), which I uſed with a little powdered quartz, nitre, and borax; it produced a very beautiful red colour.

The calx of tin I made uſe of was prepared according to the method deſcribed by M. Montamy, in his Treatiſe on Colours for Painting in Enamel, (page 51), that is, by calcination with common ſalt.

I alſo made ſome trials with the forementioned ingredients, in different proportions, and without the addition of calx of tin; but, as none of thoſe experiments ſucceeded better than that juſt deſcribed, a particular detail of them would be both uſeleſs and tireſome.

I think it proper, however, to take notice that, although the laſt-mentioned compoſition is more beautiful, when applied upon iron, and more even, than the two preceding, it has the diſadvantage, on account of the ſalts which it contains, of not reſiſting the action of the ſtronger vegetable acids, and ſtill leſs that of the mineral ones. But, as a veſſel when coated with this enamel bears, without any injury, ſudden changes of heat and cold; and alſo to have any greaſy mixtures baked or boiled in it, (even thoſe which are of a cauſtic alkaline nature, or thoſe which contain the uſual weak acids which are uſed in the preparation of our food,) it may be applied to veſſels of various kinds, among others to tea-cups; particularly as it is neither brittle, nor ſubject to crack, provided it is not expoſed to violent blows.

Iron feems to be the beft metal for coating with it, as it is the moft general, and therefore the cheapeft; befides, it may be more roughly handled than copper, upon which this enamel would foon be damaged; and, I may add that iron is lefs dangerous to health, in cafe the enamel fhould happen to be broken in any part. It is hardly neceffary to fay, that this enamel can only be applied upon veffels made of hammered iron, and not upon thofe of caft iron; thefe laft being always too thick to be heated with fufficient quicknefs; for, the greater is the fpace of time neceffary to make the veffels red-hot, the greater is the quantity of fcales formed upon them, and, of courfe, the enamel becomes more injured.

I have already obferved, that the common enamel of the fhops, and thofe compofitions of gypfum and fluor fpar, which, after being tried, were found capable of refifting the action of acids, did not anfwer for coating iron, and never had a fmooth furface. We might, however, ftill make many experiments with a view to difcover fome mixture which fhould anfwer better; we might, for that purpofe, make ufe of the mixture of fufible

glafs

glafs and glafs of lead, mentioned in the eighth experiment, as it fixes very well upon iron. But, in that cafe, and for making experiments upon a larger fcale, or upon common-fized kitchen utenfils, a ftronger degree of heat than I have yet been able to procure is neceffary; I am therefore obliged to poftpone thefe refearches to fome other time.

Experiments of this kind, and the preparation of enamel for veffels of copper or iron, might very conveniently be made in porcelain manufactories. A furnace on purpofe might be there built, in which it would probably be neceffary to keep up the fame degree of heat as is ufed in baking porcelain. Every thing requifite for painting in enamel would there be found, and alfo workmen already practifed in the art of glazing; but it muft not be fuppofed that metals could be enamelled in the fame manner, and in the fame furnace, in which the glazing is given to porcelain; for, iron and copper, when expofed for fo long a time to a heat gradually increafed, are apt to have fcales form upon them, which caufe the enamel to crack and fall of; this I have more

more than once experienced when I made uſe of the potter's furnace.

The enamel for iron, the compoſition of which I have deſcribed, may, independent of its uſe for coating kitchen-utenſils, ſerve for many other purpoſes; ſuch as, preſerving certain things made of that metal, not only from ruſt, but alſo, to a certain degree, from calcination. I found, by experience, that a piece of iron, coated with the enamel deſcribed in the ſixteenth experiment, or any other of a ſimilar kind, after being kept in a ſtrong heat, in the aſſaying furnace, for the ſpace of nine hours, had loſt by calcination only half as much as another piece of the ſame kind, which had been expoſed to the action of the ſame fire without having been coated.

I alſo found that ſmall articles of iron, ſuch as lids of boxes, handles of knives, &c. might be engraved, and inlaid with the enamel, in various figures and colours; this mode of uſing the enamel would, in my opinion, ſucceed perfectly well after the workmen had acquired a little practice in the art.

The enamel deſcribed in the ſixteenth experiment would be extremely proper for this uſe, as it is that which melts the moſt eaſily, and one to which we may give all the colours we can deſire; for inſtance, we can make it blue, with the calx of cobalt already ſpoken of; red, with the mineral purple, or with *crocus martis*; green, with calx of copper; yellow, with Naples yellow, &c. as is well known to thoſe who practiſe enamelling. We muſt only remember, that in a briſk fire the enamel melts very quickly, and conſequently take care to withdraw it before any ſcales of calcined iron may be formed, as they ſpoil the colour, and turn it black; which colour may be thus obtained without any addition. The engraving of the articles may be performed with aqua fortis; and, after the fuſion of the enamel, they will be found to have acquired a durable and agreeable ornament, and one which cannot fail to increaſe their value in foreign countries. I could not help mentioning theſe circumſtances, though they are not immediately connected with the ſubject of this enquiry.

REPERTORY
OF
ARTS AND MANUFACTURES.
NUMBER XVI.

Printed by JOHN NICHOLS, Red-Lion-Paſſage, Fleet-Street, London.

XXVIII. *Specification of the Patent granted to Mr.* JOHN TUCKER, *of Wickham, in the County of Southampton, Tanner; for his Method of Tanning, and making Leather of a ſuperior Quality, and in a much ſhorter Period of Time, than hath hitherto been done.*

Dated May 12, 1795.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid John Tucker, in compliance with the ſaid proviſo, do hereby declare, that the nature of my ſaid invention, and the manner in which the ſame is to be performed, is particularly deſcribed and aſcertained as follows;

 that

that is to ſay, the vat or pit may be made or compoſed either of wooden, earthen, metallic, or other ſubſtance fit for the purpoſe, and conſtructed in any form, or ſize, that may be neceſſary or convenient. The oozes ſhould be kept in a regular kind degree of heat, by means of a flue, connected with them by an incloſure of brick, wood, ſtone, or any kind of metal, or other ſubſtance fit for the purpoſe; but the beſt method is to make the vats of beech, (with the top-plank of oak, about two inches thick,) four feet and a half deep, ſix feet long, and four feet wide; the ſides to be perforated with holes, about one inch and a half in diameter, and two inches in diſtance from each other. The vat or pit ſhould be incloſed in a metallic coating, and ſo completely ſoldered as to prevent the eſcape of any of the fluid. There muſt be an eye made in the vat, with a hole in it, for the ooze to diſcharge itſelf through when exhauſted. The vat ſhould be placed on bricks, and incloſed with a caſe of brick-work, leaving an interſtice of a few inches for the heat to circulate in; which heat ſhould be kind and gentle, and received from a fire placed near the bottom of

of the vat, ſo as to be either increaſed or extinguiſhed at pleaſure, as neceſſity or convenience may require. A ſmall hole, or holes, muſt be left in the upper part of the brick-work, which is neceſſary for the warm air to aſcend through. The old way of cold infuſion for the extracts, as to the taps and ſpenders, will not be affected by this proceſs, and the hides may be brought into the yard as uſual; but it will be proper to handle them very frequently for ſome time, otherwiſe, as the action of the bark is very conſiderably increaſed by the warmth it has received, it will, if the hides be not often moved, operate partially, ſo as to defeat the production of perfect leather. But, if this proceſs of tanning be ſtrictly attended to, it will produce leather, not only in a much ſhorter period of time than has hitherto been done, but of very ſuperior quality, and durability. In witneſs whereof, &c.

XXIX. *Specification of the Patent granted to Mr.* WILLIAM FULTON, *of Broommuir, in the Shire of Air, North Britain, Manufacturer of Thread; for his Method of working Pumps, (as well on-board Ships as on Land,) Rubbing-Boards used in Bleaching, and all other mechanical Machines of similar Natures, by Means of a Cylinder with its Appurtenances.*

WITH A PLATE.

Dated May 22, 1788.

TO all to whom these presents shall come, &c. Now KNOW YE, that in obedience to the said letters patent, and the proviso therein contained, I the said William Fulton do hereby describe and ascertain the nature of my aforesaid invention, and the manner in which the same is to be performed, in manner following; that is to say, in Fig. 1 (see Plate XIII.) is contained a view of the cylinder, with its appurtenances, applied to pumps; wherein

A

A repreſents the cylinder, round which, in the direction from B to B, is a groove, which receives a ſtrong pin, or roller, (either of which may be applied in proportion to the friction,) placed at the bottom of, and projecting horizontally from, the pendulum lever C, which is fixed perpendicularly to the centre of the beam D D, to each end whereof the piſton-rods are hung. The cylinder being turned by the handles E E at each end of it, or one of them only, or by the application of wheels thereto, (to be turned either by water or horſes, according to the ſituation and ſize of the pumps, and the force required,) the pin, or roller, at the bottom of the pendulum lever C, is forced through the groove, and, in paſſing half round, one end of the beam D D riſes, while the other end deſcends; and, in paſſing the other half round, the motion is reverſed; ſo that, in one complete revolution to the cylinder, each pump is fully acted upon, and diſcharges the fluid through the ſpouts to be placed for that purpoſe. The method of working ſingle pumps, by means of this cylinder and its appurtenances, is exactly

exactly the ſame; for, by fixing the pendulum-lever, with the pin, or roller, at the bottom, as before deſcribed, to the centre of the lever or handle of a ſingle pump, (ſuch lever or handle moving on its centre,) and the cylinder being turned, the pin, or roller, will be forced through the groove; and, in going once round, will raiſe and fall the lever or handle of the pump, and thereby diſcharge the fluid from the ſpout. In Fig. 2 is a view of the cylinder, with its appurtenances, applied to rubbing-boards uſed in bleaching: wherein A repreſents the cylinder, and B B the groove which receives the pin, or roller, fixed at the end of, and under, the arm D, which is fixed to the upright ſhaft E, which moves between the two pieces F F; near the bottom of which upright ſhaft is fixed the croſs bar G G, at each end whereof are placed the two pieces HH; each movable on two centres, one to the croſs bar, and the other to the upper rubbing-boards I and K. The cylinder being turned, by any of the means before mentioned with reſpect to pumps, the pin, or roller, fixed to the arm

D,

D, is forced through the groove, and, in paffing half round, caufes the rubbing-board I to be drawn forward, and the rubbing-board K to be thrown back, and, in paffing the other half round, reverfes the motion; fo that, in one complete revolution of the cylinder, each of the two rubbing-boards is moved once forward and once backward. For the fake of fhewing the motion of the boards more clearly, the other apparatus belonging to the frame of the rubbing-boards is omitted in the view. All the parts of both the views are drawn upon a fcale of half an inch to a foot, on which fcale the diameter of the cylinder is drawn to be feventeen inches; its whole length thirty-three inches; the length of the groove twenty-feven inches; the breadth of the groove two inches; and its depth two inches and an half; to which breadth and depth of the groove, the pin, or roller, forced through it muft be fitted. By this fcale, the fize of the cylinder and its appurtenances, in the application thereof to pumps, and rubbing-boards, of greater or lefs fizes and dimenfions, and to all other mechanical machines or

engines

engines of ſimilar natures or conſtructions, muſt be governed. The materials, of which the cylinder, its groove, and the pin, or roller, are to be made, may be different, according to the ſize and bore of the pumps, and to the ſize of the rubbing-boards, or other machines or engines, and the greater or leſs friction of the pin, or roller, upon the groove; which muſt of courſe be in proportion to the weight to be raiſed by the pumps, and to the coarſeneſs or thickneſs of the cloth, or other commodity, to be rubbed by the rubbing-boards, and alſo to the force required to work other mechanical machines or engines of ſimilar natures or conſtructions. In witneſs whereof, &c.

Fig. 1

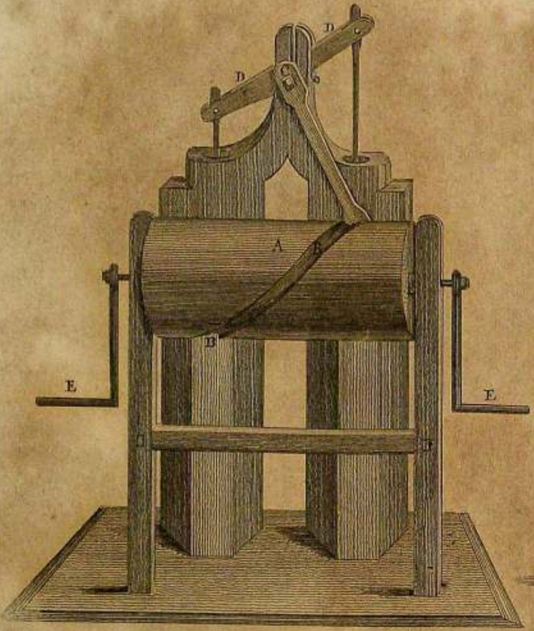
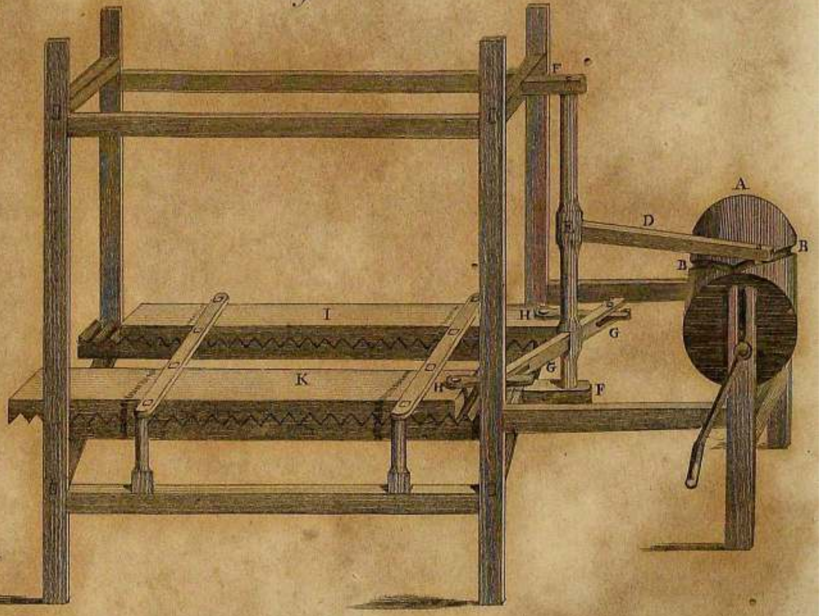


Fig. 2



XXX. *Specification of the Patent granted to Mr.* Richard Fishwick, *of Elſwick, in the Pariſh of Newcaſtle upon Tyne, White-lead Maker; for his Invention of a new Method of making White-lead.*

Dated January 15, 1787.

To all to whom theſe preſents ſhall come, &c. Whereas the general and uſual method or proceſs of preparing and making white-lead, for many years paſt, has been as follows; that is to ſay, within a brick building, or any other building, covered in, and ſecured from the weather, ſpread upon the floor a bed, ſtratum, or layer, of horſe-litter, two feet thick, or thereabouts; upon which, place cloſe to each other as many earthen or other veſſels, in ſize from a pint and a half to ſix pints each, as can be placed horizontally upon the ſurface of the ſaid bed of horſe-litter; then put, into each of theſe earthen or other veſſels, a wine-meaſure pint of vinegar, or other acid liquor;

then place or ſuſpend thin ſheets or plates of lead, looſely rolled, or folded together in a circular manner, over ſuch vinegar, or other acid liquor, in ſuch manner as not to touch ſuch vinegar, or other acid liquor; ſuch plates or ſheets to be perpendicularly placed within the veſſels, or otherwiſe, upon the edge thereof, and to be from one ſixteenth of an inch to one fourth of an inch in thickneſs; the bed, ſtratum, or layer, to contain in the whole two pounds and a half of lead, of avoirdupois weight, to each or every veſſel of vinegar, or other acid liquor, placed upon ſuch bed, ſtratum, or layer. The lead and veſſels to be then covered over with other ſimilar ſheets or plates of lead, laid flat upon the ſurface thereof, and thoſe ſheets or plates of lead, ſo laid, covered with deal boards, or with ſtraw, which completes the firſt bed, or ſtratum. The next bed, or ſtratum, and as many more as are wanted, may be compoſed and formed in the ſame manner as is above deſcribed. Then let the whole contents of the ſaid beds, or ſtrata, remain in the ſaid ſtate, until the vinegar, or other acid liquor,

is

is exhaufted, or evaporated, which will generally be in about two calendar months. Then let the bed, or ftrata, be drawn, or taken off and removed, and let the corroded and white lead be feparated from the other part of the lead, (which remains blue and uncorroded,) and mixed with fuch a quantity of water as will make it pafs between a pair of mill-ftones, and in that ftate let it be ground between a pair of mill-ftones; then let the finer parts be feparated from the coarfer, by wafhing the fame in a large veffel of water, containing five or fix fucceffive partitions or divifions, communicating with each other by a fmall paffage at the top; fo that the white-lead being pumped, poured, or ladled, into the firft of the faid partitions or divifions, the finer parts thereof may pafs off into the other fucceffive partitions or divifions; the laft three of which will contain the fine lead, which muft be taken out and put into another back, or large tub, to fubfide, and then the water fhould be carefully removed, or ladled off; and, after a few days, when the lead is become nearly of the confiftence of a pafte, it muft

be expoſed to the air, or to the heat of a ſtove, in ſmall flat lumps or parcels, of about ſeven pounds each, ſeparate from each other, until it is perfectly dry. Now KNOW YE, that, in compliance with the aforeſaid proviſo, in the ſaid letters patent contained, and for particularly deſcribing and aſcertaining the nature of my ſaid invention, and the manner in which the ſame is to be performed, (having previouſly deſcribed the general or uſual method or proceſs of making or preparing white-lead, as aforeſaid,) I, the ſaid Richard Fiſhwick, by this inſtrument in writing, under my hand and ſeal, intended to be forthwith enrolled in his Majeſty's High Court of Chancery, do teſtify and declare, that my ſaid invention is the ſubſtituting in ſuch proceſs for preparing or making white-lead, as aforeſaid, in the room or place of horſe-litter, the uſe of the common tanners bark, or of the bark of the oak-tree, after the ſame has been previouſly applied or uſed by tanners, for making the liquor or tan which is uſed in tanning, and preparing hides for leather; and that I have found, by repeated experiments, that ſuch tan-

ners

ners bark will communicate a more certain and equal degree of heat to the vinegar and lead, placed over or upon it, than the horſe-litter has hitherto been found to do. And I do hereby far her declare, that the manner of applying the bark, in ſuch method or proceſs of making white-lead, as aforeſaid, is to ſpread upon the floor of ſuch brick or other building, as aforeſaid, a bed of ſuch tanners bark, as aforeſaid, of one foot thick, or thereabouts, in the room or place of a bed of horſe-litter of two feet thick, or thereabouts, as aforeſaid; and ſo with the next bed or ſtratum, and ſo many more as may be wanted, as aforeſaid, adding or applying the other herein-before-mentioned articles, ingredients, or things, in the ſame proportions, quantities, and manner, as is herein before-mentioned or expreſſed to be the general or uſual method or proceſs of preparing or making white-lead. And I do hereby farther declare, that any tanners bark which will anſwer or do for the purpoſe of making the liquor or tan which is uſed in tanning, or preparing hides for leather, will alſo anſwer, and be applicable, as a

ſubſtitute for horſe-litter, in the proceſs aforeſaid. And foraſmuch as my ſaid invention is the ſubſtitution or application of tanners bark, in the room or place of horſe-litter, in the preparation or making of white-lead, (in which tanners bark has not hitherto been uſed,) therefore if, in preparing or making white-lead, you do uſe tanners bark, though the other ingredients and things made uſe of, and the proportions and manner of uſing the ſame, are different from or other than thoſe herein before deſcribed to be the general or uſual method or proceſs of preparing or making white-lead with horſe-litter, yet nevertheleſs, in ſuch caſe, you do uſe the invention which I do hereby deſcribe. In witneſs whereof, &c.

XXXI.

XXXI. *Specification of the Patent granted to Mr. JONATHAN TAYLOR, of Birmingham, in the County of Warwick, Iron-founder; for his Invention of casting oval-bellied iron Pots, and nealing, turning, tinning, and finishing the same, and other Kinds of cast-iron Pots, and Saucepans.*

Dated Aug. 10, 1779.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE, that, in compliance with the said proviso, I the said Jonathan Taylor do hereby declare, that my said invention of casting oval-bellied cast-iron pots, and of nealing, turning, tinning, and finishing, the same; and also nealing, turning, tinning, and finishing, all kinds of round cast-iron pots, and saucepans, as are made with a bead or rim round the top, is described in the following manner; that is to say, the pattern, from which the oval-bellied cast-iron pot is to be cast,

consists

conſiſts of braſs or copper, worked into the proper form of ſuch a pot, and cut down the middle into two parts; it is then moulded in ſand, incloſed in an iron box or mould, which box or mould conſiſts of four parts; that is, a top part, a bottom part, and two middle parts, (made with great exactneſs to ſlide on the bottom part, ſo as to move on and off without deviation,) with a quantity of ſmall holes in the ſaid two middle parts, to give vent to the air, which ruſhes out when the hot metal is poured in. The article is then nealed, by incloſing the ſame in a caſt-metal pan, covered with coal-duſt or aſhes, ſo as to prevent the air getting to it as much as poſſible; which pan is ſurrounded by fire till the pot becomes of a proper ſoftneſs, which is generally in about twenty-four hours. The turning of pots is performed by an oval lathe, made for that purpoſe, upon a large conſtruction, and very ſtrong; the pot being fixed into a chock or hollow piece of wood, to hold it while turning. The tinning and finiſhing is performed by holding the pot to be tinned over the fire, till it becomes of a regular

proper

proper heat to receive the tin; when a proper quantity of grain-tin, mixed with ſal-ammoniac, is put into it, the pot being ſtill kept over the fire, and the tin worked about with ſal-ammoniac till it takes and adheres to the pot in a proper manner. Round pots and ſaucepans, with beads or rims round the tops, are nealed by the ſame method as oval pots are: the turning of them is performed in a round lathe, the article being fixed in a chock as before mentioned. The beads and rims round the tops are likewiſe turned by the ſame method, in order to make them clear and bright in a proper ſtate to receive the tin; the tinning and finiſhing is performed in the ſame manner as the oval pots, the beads or rims round the top being tinned at the ſame time, and by the ſame method, as pots or ſaucepans are tinned. In witneſs whereof, &c.

XXXII. *Deſcription of a ſimple Inſtrument for taking perpendicular Heights, without any Calculation whatever; in a Letter to the Editors.*

WITH A PLATE.

I HAVE taken the liberty of ſending you a ſketch of a ſimple little inſtrument, which I thought of ſome time ago, for taking perpendicular heights without any calculation whatever. This certainly is no object to a mathematician; but it may be uſeful to thoſe who are unacquainted with trigonometry. If you judge this trifle worthy of inſertion in your Repertory, it is very much at your ſervice. I am, &c.

J. M.

A B C (Fig. 1. Plate XIV.) is a piece of braſs, wood, or any other ſubſtance whatſoever; upon this draw the line B C, near the edge; then draw the line A B, taking care to let the angle A B C be exactly of 45 degrees. Then place the three ſights; the one marked B is to have a ſmall hole in

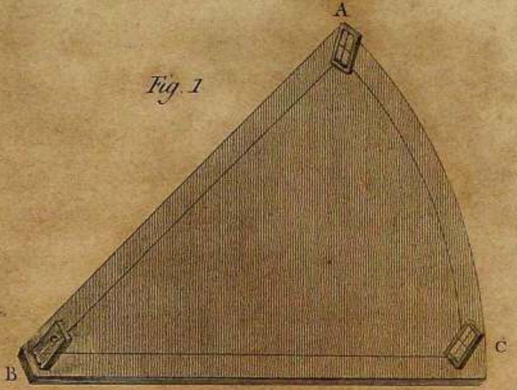
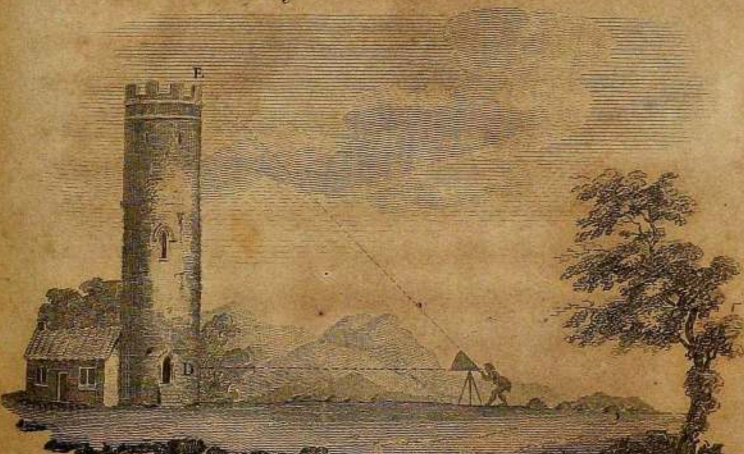


Fig. 1

Fig. 2



in it, which is to be put exactly over the point of interſection of the two lines A B and B C. The other two may be made the ſame, but I prefer a ſmall frame, as in the figure, with a fine thread ſtretched acroſs it; theſe are to be placed in any part of the lines, in the circumference of a circle drawn from the point where they meet.

To uſe this inſtrument nothing more is neceſſary than to find your own height, or that of the ſtand of your inſtrument, if it has any; and, at the ſame height upon a wall or tower, (ſee Fig. 2.) to fix a wafer or other mark, as at D; then, having ſeen that mark through the two bottom ſights B C, walk backwards until you ſee the top of the tower E, through the other ſight A; then ſtop, and meaſure the diſtance between yourſelf and the tower; which, added to the height of the wafer, will give you the height of the tower.

By uſing the inſtrument horizontally, inſtead of perpendicularly, the diſtance of an object, which on account of a river, &c. cannot be approached, may be meaſured, provided no great degree of accuracy is required.

XXXIII. *On Irrigation, or watering Land; with ſome Obſervations on the Uſe of Reſervoirs for Flood Waters.*

From the general View of the Agriculture of the County of Stafford; drawn up, for the Conſideration of the Board of Agriculture, by WILLIAM PITT, Eſq. of Pendeford, near Wolverhampton.

IRRIGATION, or the improvement of land by watering, is, or may be, a very important and extenſive part of agriculture; and though the advantages to be derived from it are generally admitted and well known in this country, at leaſt by all intelligent farmers, yet it is by no means in general carried to the extent of which it is capable; many ſtreams being ſuffered to glide quietly down their own channel, which might eaſily be drawn over the adjoining lands, to their great improvement. This omiſſion is in part owing

owing to neglect; in part to the jealoufy of millers, and other perfons interfted in the ftreams; and, in fome degree, to the beft methods of extending this application of water not being generally and fufficiently underftood. The induftry of many individuals is, however, very properly and fuccefsfully exerted in this very commendable fpecies of improvement.

Refpecting a fyftem for irrigation, no general one can apply to particular cafes: different modes of fpreading the water muft be adopted, according to different circumftances of fituation, and form of furface. In all cafes where a ftream naturally falls down a valley, and the fides of fuch valley confift of eafy and regular declivities, the beft way undoubtedly is to draw a fufficient quantity of water nearly upon a level, along a main carrier; fuch water to be let out of the faid main carrier, at pleafure, by fluices conftructed in different places in the fides thereof, into floating gutters; fuch floating gutters being cut on a level along the fides of the declivities, one below another. Thefe floating gutters will collect the water from the fpaces of land above them, and, if well conftructed,

ſtructed, deliver it very regularly upon the ſpaces below each of them reſpectively. The watering in this caſe will require very little attendance, except that of opening and cloſing the ſluices in rotation, ſo as to irrigate different parts of ſuch land ſucceſſively. The gutters too will require an annual cleanſing, or ſcouring out, otherwiſe they will choke, and grow up with graſs.

The particular mode of action, or operation, by which land is benefited by watering, has not perhaps hitherto been ſatisfactorily explained; yet it is an eſtabiſhed and well-known fact, that all waters (except ſuch as are highly putrid) produce a good effect upon land, in ſome degree proportioned to their rapidity or briſkneſs of motion. Thus, common water, ſuffered to ſtagnate upon, or dribble in ſmall quantities over land, will encourage the growth only of ruſhes, ſea-graſs, (*carex*,) and other coarſe aquatics, and weaken, if not deſtroy, the fineſt and moſt valuable graſſes. The ſame water, driven over the ſame land with a briſk motion, and the ſurface left to dry at intervals, and expoſed to the ſun and atmoſphere, will have a direct contrary effect; the valuable graſſes

will flouriſh, and the aquatics be weakened or deſtroyed. Hence it ſhould ſeem, that the good effects of watering are in part produced by mechanical operation, by moiſtening and tendering the ſurface; which circumſtance, combined at intervals with the effects of the ſun and atmoſphere, brings into action the latent principles of vegetation in plants; which principles would have lain dormant, under the influence of chilling or ſtagnant water; or would have been locked up by the matting of turf on the ſurface, had not ſuch turf been ſoftened, and made eaſily penetrable, by moiſtening its ſurface. The coarſe aquatics, being hardier, vegetate in a leſs degree of heat; they ſeem intended by nature to fill up thoſe vacancies which are yet unprepared for the production of the more valuable tribes, upon this principle in her vegetable œconomy, that a bad plant is better than none; yet, upon the proper application of human induſtry, they always decline, and give way to thoſe of ſuperior value.

Every one knows the neceſſity there is (previous to improvements by irrigation) of diſcharging the ſtagnant water from, or from near, the ſurface

face of all lands intended to be ſo improved, by hollow drains or otherwiſe.

As the benefit to be derived from irrigation depends ſo much upon the watering being effected with a briſk motion, and not continued for too long a time, the great deſideratum in this ſpecies of improvement ſeems to be the introduction of reſervoirs, conſtructed ſo as to contain large quantities of flood water; which water, ſo collected, may be ſucceſſively, and at pleaſure, diſtributed upon any land below its ſurface, and continued with ſuch velocity, and for ſuch length of time, as may be thought proper.

This idea, as applicable to agriculture, is I believe novel, and may be treated as viſionary; but I am ſo thoroughly convinced of the great advantages to be derived from it, that I will venture a prediction of its being, in ſome future time, practiſed to a great extent. The practice will be much facilitated by the conſtruction of dams being ſo well and ſo commonly underſtood, in conſequence of the number of navigable canals which have been, and are ſtill executing. A reſervoir of a few acres, and of two yards average depth,

depth, may be conftructed as from ten to twenty pounds *per* acre, according to circumftances of fituation. Such a refervoir, as a fifhery, (under proper management,) would be equal or fuperior in value to an equal breadth of land, and the furface water, to a certain depth, might be drawn down, for the purpofe of irrigation, at pleafure.

Upon this fubject of water, the following extenfive idea is thrown out by an ingenious gentleman *, high in his profeffion as an engineer; which is, that nine parts in ten of the waters of the kingdom at prefent run away in wafte, great parts of which might be ufefully employed; nay farther, (putting expence out of the queftion,) that every ftream in the kingdom may be made to run equally through the whole year. This pofition, however extraordinary, is eafily demonftrable; for, if upon any given ftream one or more refervoirs be made, capable of containing its flood water, and through the dam or dams be laid a pipe or pipes, whofe apertures will juft difcharge the average produce, the bufinefs is done. And, though there may be no probability of this

* Mr. Jeffop.

bufinefs being ever brought to fo great a nicety, yet hence fome idea may be formed of the prodigious extent to which improvements by water may be carried.

With this fubject, and that of forming refervoirs for the purpofes of agriculture, is connected another, of great importance in domeftic and commercial œconomy; namely, the having an extenfive command of the application of water, to all mechanical purpofes wherein fuch application will anfwer better than for irrigation of land, and that, as it were, arrefting every drop of water that falls from the heavens, and rendering it, in the moft extenfive way, fubfervient not only to the immediate fubfiftence of man and beaft, and the improvement of land, but even having the refidue folely at command, for the purpofe of fhortening manual labour: fuch fyftem would certainly be an important addition to the powers required in many of our mechanical operations, and of great importance in a manufacturing country.

A copy of part of the above being fent to Mr. Jeffop, I received from him the following paper, which I had never feen before.

Obferva-

Obſervations on the Uſe of Reſervoirs for Flood Waters.

The rapid improvements which have for ſome years paſt been made in the agriculture and commerce of this country, and the happy effects derived therefrom, naturally excite a deſire to inveſtigate every means by which they may be continued and increaſed.

Among the many cauſes which have combined to promote our proſperity, the facility of intercourſe by inland navigation is a great and leading feature. All unite in admitting this as a general poſition; but many, from private motives, or miſtaken opinions, have too often prevailed in preventing the execution of uſeful projects, which, if they could have been effected, would have greatly contributed to the national benefit derived from thoſe already eſtabliſhed.

Among the obſtacles that ſtand forward, none is more conſpicuous, nor more generally urged, than the want of water in dry ſeaſons. It uſually

 happens,

happens, that, where canals are moſt wanted, manufactories, or agriculture, have already taken poſſeſſion of the ground, and occupied the ſtreams of water; it is plainly to be foreſeen, therefore, that, unleſs ſome means are deviſed to reconcile this competition, thoſe deſirable improvements muſt be crippled in their growth, and ſtop long before the age of maturity.

It can hardly have eſcaped any one's obſervation, that ſtreams of water uſed for the purpoſe of working mills, or the more valuable purpoſe of watering meadows, (in the few inſtances where this has been practiſed,) while they have a ſcanty ſupply in ſummer, generally diſcharge in winter ſuch ſuperabundance as frequently to do material injury.

There are, in ſome parts of this iſland, exceptions to this general poſition. Where the ſoil is porous, and the *ſubſtrata* ſo open as to abſorb the rains as they fall, there are no floods: the pores and fiſſures of the earth form reſervoirs or regulators to the ſtreams; they preſerve the winter waters, and ſo equalize the diſcharge, that there is

is but little difference between their winter and ſummer ſtate; but in clay, or other ſimilar ſoils, ſo little is abſorbed, and ſo much ſuddenly glides off from the ſurface, that the extremes of ſcarcity and exuberance are the neceſſary conſequences.

It is now well underſtood, that all natural ſprings derive their ſupplies from the waters of the atmoſphere, and they may fairly be conſidered as the diſcharges of natural reſervoirs; it is immaterial whether theſe reſervoirs may be compoſed of large cavities or minute fiſſures.

Leaving expence out of the queſtion, it is poſſible to conceive (however extravagant the idea may appear) that the waters of all rivers might, by art, be nearly equalized throughout the year; but it will be ſufficient to prove that this is practicable if applied to ſmall rivulets or brooks, particularly where nature holds forth a temptation, by furniſhing deep ravines, or capacious hollows on the ſurface of the ground, capable, at a moderate expence, of being made to contain large quantities of water.

We

We are taught, from the ſimple inſtinct of animals, the provident leſſon of ſtoring up the ſuperabundant ſupplies of one ſeaſon for the wants of another. Neceſſity has compelled mankind, in many countries, to follow this example: in hot climates the inhabitants can hardly exiſt, without ſtoring up the waters of winter for their uſe in ſummer *.

Theſe are inſtances, in this country, where canals are in want of water in ſummer; while the brooks that ſupply them diſcharge floods, in winter, in one day, ſufficient for the ſupply of the whole year.

Thoſe who entertain doubts of the practicability of making reſervoirs ſufficient for the ſupply of canals, ſtate their objections under three heads: the expence; the want of ſufficiency of water; and the uncertainty of making ſuch reſervoirs capable of retaining it.

When the neceſſary magnitude is aſcertained, the expence is a ſubject of plain calculation; and it

* At Alicant the king of Spain has made a reſervoir, the water of which, for the uſes of ſummer agriculture, brings him in a revenue of 2000 *l. per annum.*

it is eaſy to determine whether the project, to which it is to be applied, will bear the expence. There have been ſeveral inſtances, where the expences of repelling an oppoſition, from mill-owners, to a bill in parliament, would have been more than enough to have made ſufficient reſervoirs.

Whether they can be filled with water may be known before they are undertaken, by an enquiry and meaſurement of the diſcharge in winter.

The waſte of water from a reſervoir is in two ways; by exhalation, and by leakage. The firſt, in a dry ſummer, would conſume about nine inches in depth from the ſurface; making the head nine inches higher than otherwiſe neceſſary would compenſate for this. The leakage would be in few caſes, (where it would be prudent to attempt the ſcheme at all,) even upon ſmall ſtreams, more than equal to the ſummer ſupply; and, whether the water be diſcharged by leakage, or by a pipe or artificial diſcharger, if they ſhould both diſcharge into the ſame channel, is not very material. In clay, or other ſoils

when rufhes grow, there will be no fenfible leakage; in folis more open, the pores of the foil would be an extenfion of the refervoir; and, in cafes where it may be neceffary to difcharge conftantly from the refervoir a quantity equal to the fummer ftream, it would, for a time, fupply that difcharge.

Even in extreme cafes of leaky foils, if there were any fudden floods, the refervoir would at leaft prevent their fudden difcharge; but, where the foil and *ftrata* are fo clofe as to abforb little, and caufe fudden floods, (and it is to thefe cafes that refervoirs are peculiarly applicable,) there is little reafon to apprehend leakage.

The writer of this has lately had an opportunity of experiencing the effect of a fmall refervoir, not yet completed, as a regulator to a ftream. It covers at prefent about twenty acres, and is made on a fmall brook, which, in dry feafons, does not furnifh more water than would run through an aperture of an inch in diameter, but is fubject to floods, which can hardly be difcharged by a pipe of three feet in diameter.

There

There is fixed under the head of it an iron pipe of ſix inches bore, which, during the laſt winter, has almoſt conſtantly been open; and diſcharged a quantity no otherwiſe unequal than from the difference of preſſure, by the riſing and falling of the water in the reſervoir, at the different intervals of rainy and fair weather; and, when the reſervoir ſhall be enlarged, on the one hand, the meadows below will never be overflowed, and, on the other hand, the reſervoir will furniſh, in the dry part of the ſummer, *at leaſt twenty times* the quantity of water daily that the brook would otherwiſe afford.

There is now depending in parliament a bill for making a navigable canal through the vale of Belvoir to the town of Grantham, where the ſoil is almoſt wholly a firm tenacious clay, and will not require above half the water to ſupply it which is neceſſary for canals in other inſtances.

That country is ſubject to an extreme ſcarcity of water in ſummer, and to a great ſuperabundance in winter; and every circumſtance is favourable to the intention of ſupplying the canal

 by

by artificial reſervoirs. It is therefore earneſtly hoped, that thoſe who might be induced by their doubts to repel the intention, (under the idea that becauſe no canal had hitherto been totally ſupplied by reſervoirs, therefore it muſt be impracticable,) will give ſome credit to thoſe who, on well-grounded information, have adviſed the meaſure, and that they will ſuffer it to be effected.

It is alſo hoped, that the execution of a canal, upon this ſyſtem, may tend to promote the extenſion and continuance of thoſe improvements in commerce and agriculture, on which ſo greatly depends the proſperity of this country; and which, in many inſtances, have been already checked, by neglecting to employ the aſſiſtance of art in remedying the defects, or rather in uſing or improving the bounties, of Nature.

Written in May, 1792. W. JESSOP.

Farther, reſpecting the particular ſubject of applying water to the improvement of land, though this practice is by no means carried to the extent of which it is capable, and large quantities

tities of flood-waters are loſt; (which, in the tenacious clay-ſoils that abound over a conſiderable part of this country, can be retained in no other way than by artificial reſervoirs,) yet conſiderable exertions are made in this buſineſs by many perſons, and omitted by few who have the means of doing it; almoſt every occupier, who has a ſtream through his meadows, beſtowing conſiderable attention to it in floods. Amongſt others, my neighbour Mr. Miller, of Dunſtall near Wolverhampton, has upwards of one hundred and eighty acres of land capable of irrigation; and, when water abounds, it is applied to this purpoſe in various ways. Upon his farms are two mill-ponds, and the mills kept in uſe in his own hands. The jealouſy of the millers below, upon the ſame ſtream, prevents his applying it to this purpoſe at any time except when there is plenty of water; on which occaſion he often rakes up the mud of his mill-ponds, by ſmall harrows dragged in them to and fro by ropes, and the mud is by this means ſent in the water over the land; which water is drawn, in floating-gutters, in every part

 of

of the land the level will admit; and the confequence is an early and plentiful hay-harveft, often after fpring-grazing. There are few inftances, in this country, of land formed artificially for the purpofe of receiving water by irrigation, by being laid in broad ridges; and the few I have feen would certainly induce any attentive perfon to reject the method. The foil is feldom left equally upon the land; and the length of time loft, before a good turf can be reftored, is a great objection to the practice; and, as the water may, in almoft all cafes, be as well applied upon an even furface varioufly difpofed, as land often is by nature, I think fuch mode of application is to be preferred to breaking the turf, and giving it a new form. Upon the eftate of Lord Bagot, adjoining Tedbrook, I obferved a confiderable tract of formerly moraffy land, after draining and being made found, prepared for irrigation in a very ingenious way; without altering the natural difpofition of the turf, the bufinefs was effectually done, and meant to be gradually and progreffively extended down the valley. At Stoke, near Stone, about fifty

acres

acres of meadow-land are watered in a very ſuperior ſtyle, from the Trent, and from land-floods, by Meſſrs. Jenkinſon. Here the main gutters or carriers are conſtructed with ſome fall down the land; and from them are cut ſideways a proper number of floating gutters, upon an exact level. Below each of theſe floating gutters, in the main carriers, are fixed wooden trunks laid in a puddle, with a ſliding paddle to each; by means of which the water is either kept back along the floating gutters, and ſo forced upon and over the land, or drawn down the main gutters, and off the land at pleaſure: the gutters are generally conſtructed deep enough to drain the land, when not uſed for floating. Theſe meadows have been much improved by this practice, which commenced about ſeven or eight years ago; before which, I was informed, they were of little value, but at preſent, after ſpring-grazing, they produce a full crop of hay, and are improving every year.

XXXIV. *Deſcription of two Pendulums; with an Account of a Clock where the Maintaining-Power is applied immediately from the Eſcapement-wheel to the Axis of the Pendulum-rod; by Mr.* JOHN CROSTHWAITE, *Clock and Watchmaker, in Dublin.*

WITH A PLATE.

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

FIG. 1 (Plate XV.) repreſents a pendulum, with a ſimple mode of compenſation, which has now been going eighteen years, much more accurately than could be expected in ſo very unfavourable a ſituation; the firſt ten years againſt a lath-and-plaſter partition, within three feet of the external wall, and the ſame diſtance from a hall-door, the frequent ſhutting of which muſt have very much diſturbed its vibrations; the laſt eight years, againſt an external wall, only three feet from the ſtreet, which, though a much better ſituation than the former, yet even here it was liable to have

have its isochronism disturbed by the carriages almost constantly passing.

A and B are two rods of steel, forged out of the same bar, at the same time, of the same temper, and in every respect similar. On the top of B is formed a gibbet C; this rod is firmly supported by a steel bracket D, fixed on a large piece of marble E, firmly set into the wall F, and having liberty to move freely upwards between cross staples of brass, 1, 2, 3, 4, which touch only in a point in front and rear; the staples having been carefully formed for that purpose. To the other rod is firmly fixed, by its centre, the lens G, of twenty-four pounds weight, although it should in strictness be a little below it: this pendulum is suspended by a short steel spring on the gibbet at C, all which is entirely independent of the clock. To the back of the clock-plate, I, are firmly screwed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining-power is applied by a cylindrical steel stud, in the usual way of regulators, at M. Now, it is very evident that any expansion or contraction that takes place, in either of these exactly-

similar

ſimilar rods, is inſtantly counteracted by the other; whereas, in all *compenſation-pendulums* compoſed of different materials, however juſt the calculation may ſeem to be, that can never be the caſe; as not only different metals, but alſo different bars of the ſame metal, that are not manufactured at the ſame time, and exactly in the ſame manner, are found by a good pyrometer to differ materially in their degrees of expanſion and contraction; a very ſmall change affecting one and not the other. This, however, is by their framers always tried by the pyrometer, and any defect experimentally remedied by hammering or filing; but it, notwithſtanding, requires a length of time, much expence, and an inſtrument always accurate. It is very evident that, whenever diſſimilar rods are introduced to counteract each other, diſorders will take place in the moſt ſuſceptible, ſome time before the remedy is applied by the moſt tardy, and that this remedy or compenſation continues ſome time after the occaſion for it ceaſes; and therefore, in this country, where the temperature of the atmoſphere is ſubject to ſuch various and ſudden changes, when

compen-

compenſations are uſed, they ſhould be executed with the ſame materials as that of the pendulum-rod, and have exactly the ſame expoſure to the air.

Deſcription of a Pendulum, with a Diamond Suſpenſion.

(See Plate XV. Fig. 2.)

The lens A is ſeven inches in diameter, made of lead melted into a braſs ſhell, very accurately weighed in all poſitions, turned truly in a very ſteady lathe, firſt flatwiſe, then on an arbor through its centre, and adjuſted ſo that in all ſituations the centre of gravity of the lens exactly coincides with the axis of the pendulum-rod; a piece of braſs, half an inch thick, three inches and a half long, and two broad, is let into the lead, ſo as to be even with its ſurface; four holes being tapped in it to receive the ſcrews *b b b b*, with their heads counterſunk in the braſs ſhell. This piece of braſs is hollowed lengthwiſe on the inſide, ſo as to embrace the pendulum-rod the whole length of itſelf, but moſt ſtraightly at its centre. The lens is never to be altered after the

clock is brought to time. The rod *c c* is made of red deal, firſt baked, then boiled in linſeed-oil for a conſiderable time, and then well varniſhed. On the top is formed an irregular octagon, with an opening cut through, of the ſhape of the letter U; there is drilled in the lathe, exactly through its centre, lengthwiſe, a hole to receive the piece of very hard caſt-ſteel *d*, which, after being fitted ſquare into a braſs collar *e*, paſſes through the hole in the upper part of the pendulum-rod at *f*, and is there firmly ſecured by a ſcrew, the head of which is counterſunk in the top of the rod; at g the ſteel piece is wrought to a fine conical point, on which the whole pendulum is ſuſpended, on the well-levelled face of a large diamond; this diamond is ſet, and ſoldered with ſilver, into a tempered piece of ſteel *h*, having three levelling ſcrews *i i i*, carefully tapped through it. The points of theſe tempered ſcrews are rounded, and lie in beds formed for them in a piece of ſteel *k*, ſeven-tenths of an inch broad on the upper ſide, the lower part being rounded; this is very firmly leaded into a piece of ſtatuary marble *l*, of about two hundred weight, firmly in-

ſerted

ſerted in the wall, ſo as juſt to admit the ſteel piece *k* to paſs through the back of the clock-caſe; the pendulum being entirely detached from the clock, and ſuſpended on the diamond, and the whole upon the wall. Before the clock was applied, it continued vibrating twenty-ſeven hours, in this detached ſtate, as a ſimple pendulum. I have applied the maintaining power from the movement by a well-tempered and poliſhed ſteel cylinder, one-twelfth of an inch in diameter, firmly ſcrewed to the crutch, through the opening in the braſs collar *m*; in this opening I have fixed two pieces of ſapphire, of which this is the ſection , the cylindrical ſides, which the hard ſteel cylinder above-mentioned acts againſt, being well poliſhed, the contact is lineal. To the back of each of thoſe pieces of ſapphire I have fitted two ſcrews *n n*, tapped through the braſs collar *m*, which firmly embraces the pendulum-rod. By theſe ſcrews the pieces of ſapphire are accurately adjuſted to the ſteel cylinder, ſo that the power is applied, without the ſmalleſt ſhake, or loſs of force, exactly in the line of the centres of oſcillation, gravity, and ſuſpenſion.

Account of a Clock where the maintaining Power is applied immediately from the Eſcapement-wheel to the Axis of the Pendulum-rod, without Verge, Crutch, or any other Agent.

(See Plate XV. Fig. 3 and 4.)

I cut a notch in the pendulum-rod, deeper than its axis, (ſee a front view at Fig. 3, and ſide view at Fig. 4.) and in that notch at *o*, on a plate of braſs, fixed firmly by ſcrews two pallets *p* and *q*; (repreſented larger at *r*;) and, by the eſcapement-wheel *s*, with pins 1, 2, 3, 4, 5, 6, &c. made of very hard-drawn braſs wire, inſtead of teeth, I applied the maintaining power, exactly in the line of the centres of magnitude, oſcillation, ſuſpenſion, motion, and gravity. This appears to me the moſt ſimple and perfect method of applying the maintaining power to pendulums that has hitherto been thought of; and if perfectly executed with ruby or ſapphire pallets, and hard ſteel pins well finiſhed in the wheel, the point of ſuſpenſion made perfectly immovable, and

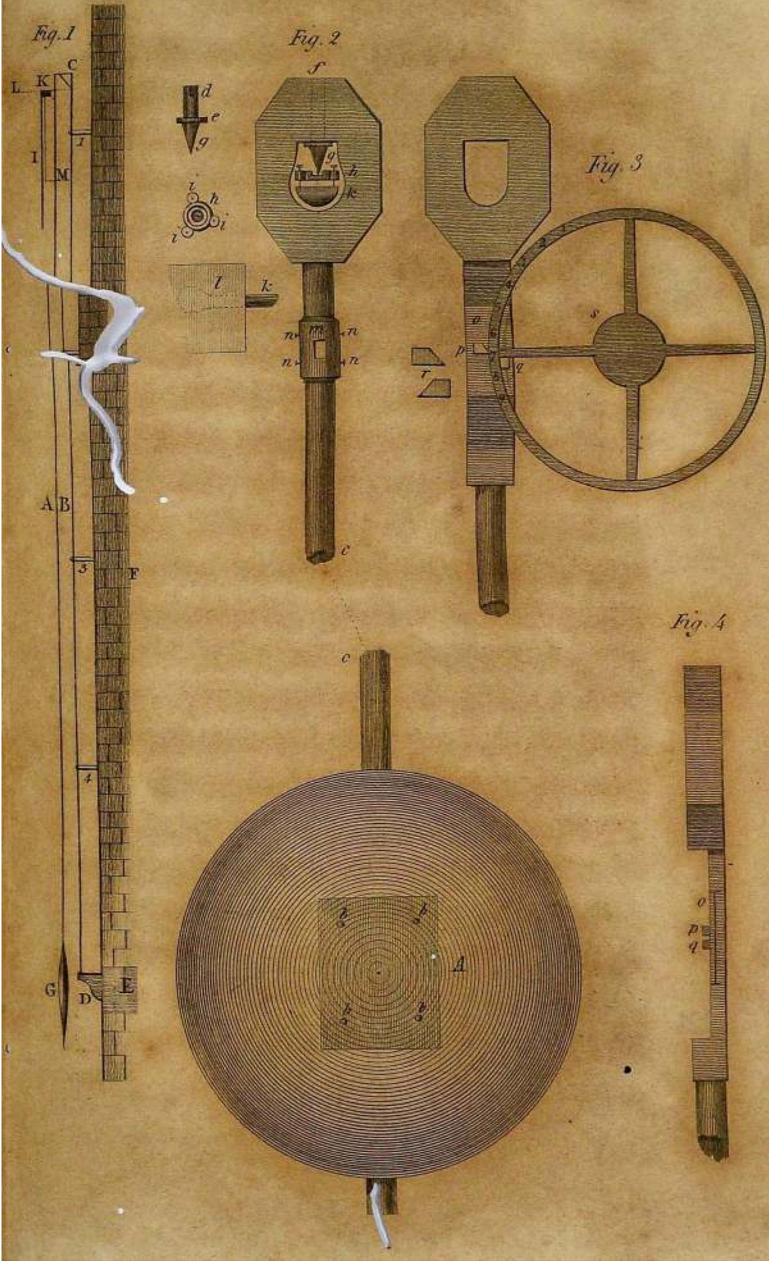


Fig. 1
L
K
C
I
M
A B
F
G
D
E
Fig. 2
f
d
e
g
h
i
l
k
m
n
c
A
Fig. 3
s
o
p
q
r
Fig. 4
o
p
q

and the maintaining power perfectly uniform, then perhaps the fairest trial may be given to different pendulums.

On shewing my clock, made in this way, to an ingenious gentleman from London, he told me he had seen one executed on the same principles in England. I went to see it, and found it somewhat like mine, but the maker had not those matters in view that I had, as he did not communicate the power at the centre of the rod, but on its external part, by which means much of the power was lost, and the remainder gave the pendulum an undulatory motion, which added considerably to the friction, and totally destroyed the isochronism.

Since these clocks were made, I constructed another very simple one, in which I made the pendulum to vibrate at right angles with the plane of the escapement-wheel: this method promises some material advantages, particularly in large clocks.

XXXV. *Continuation of Mr.* Keir's *Experiments and Obſervations on the Diſſolution of Metals in Acids, and their Precipitations, &c.*

(from p. 193.)

Section III.

The Change of Properties communicated to the Mixture of vitriolic and nitrous Acids by Phlogiſtication.

20. The above deſcribed compound acid may be phlogiſticated in different methods, of which I ſhall mention three.

Firſt. By digeſting the compound acid with ſulphur, by means of the heat of a water-bath, the liquor diſſolves the ſulphur with effervеſcence, loſes its property of yielding white fumes, and, if the quantity of ſulphur be ſufficient, and the heat applied be long enough continued, it exhibits red nitrous vapours, and aſſumes a violet colour.

Secondly, If, inſtead of diſſolving nitre in concentrated vitriolic acid, this acid be impregnated with

with nitrous gas, or with nitrous vapour, by making this gas or vapour paſs into the acid, this compound will be phlogiſticated, as it contains not the entire nitrous acid, but only its phlogiſticated part, or element, the nitrous gas, without the proportion of pure air neceſſary to conſtitute an acid. This impregnation of oil of vitriol with nitrous gas or nitrous vapour was firſt deſcribed, and ſome of the properties of the impregnated liquor noticed, by Dr. Prieſtley. See Experiments and Obſervations on Air, Vol. III. p. 129 and 217.

Thirdly. By ſubſtituting nitrous ammoniac, inſtead of nitre, in the mixture with oil of vitriol.

21. The compound prepared by any of theſe methods, but eſpecially by the firſt and ſecond, differs conſiderably in its properties, with regard to its action on metals, from the acid deſcribed in the firſt ſection. It has been obſerved, that the latter compound has little action on any metals but ſilver, tin, mercury, and nickel. On the other hand, the phlogiſticated compound not only acts on theſe, but alſo on ſeveral others. It forms with *iron* a beautiful roſe-coloured ſolution, without application of any artificial heat; and in time

a roſe-

a roſe-coloured ſaline precipitate is depoſited, which is ſoluble in water with conſiderable effervеſcence. It diſſolves *copper*, and acquires from this metal, and alſo from regulus of *cobalt*, *zinc*, and *lead*, pretty deep violet tinges. *Biſmuth* and *regulus of antimony* were alſo attacked by this phlogiſticated acid.

To aſcertain more exactly the effects of this phlogiſticated acid on ſome metals, I made the following experiments, with a liquor prepared by making nitrous gas paſs through oil of vitriol during a conſiderable time.

22. To 200 grain-meaſures of the oil of vitriol impregnated with nitrous gas, put into a retort with a long neck, the capacity of which, including the neck, was 1150 grain-meaſures, I added 144 grains of ſtandard ſilver, and immerſed the mouth of the retort in water, under an inverted jar filled with water, to catch the gas which might be extricated.

The acid began to diſſolve the ſilver with effervеſcence, by application of heat; the ſolution became of a violet colour, and the quantity of nitrous gas received in the inverted jar was 1470 grain-

grain-measures. Upon weighing the silver remaining, the quantity which had been dissolved was found to be 70 grains. When water was added to the solution an effervescence appeared, but only a very small quantity of gas was extricated. By means of the water a white saline powder of silver, soluble in a larger quantity of water, was precipitated from the solution. The solution of silver, when saturated and undiluted, congeals readily in cool temperatures, and, when diluted to a certain degree with water, gives foliated crystals.

23. In the same apparatus, and in the same manner, 100 grain-measures of this impregnated oil of vitriol were applied to *iron.* An effervescence appeared, without application of heat; the surface of the iron acquired a beautiful rose colour, or redness mixed with purple, and this colour gradually pervaded the whole liquor, but disappeared on keeping the retort some time in hot water. Notwithstanding a considerable apparent effervescence, the quantity of air expelled into the inverted jar was only 400 grain-measures, of which $\frac{1}{4}$ was nitrous, and the rest phlogisticated.

The ſolution was then poured out of the retort, and the iron was found to have loſt only two grains in weight. The ſolution was returned into the retort, without the iron, and 200 grains of water were added to it; upon which a white powder was immediately precipitated, which was re-diſſolved with great effervefcence. When 2000 grain-meaſures of nitrous gas had been expelled into the inverted jar, without application of heat, the retort was placed in the water-bath; the heat of which rendered the effervefcence ſo ſtrong, that the liquor boiled over the neck of the retort, ſo that the quantity of gas extricated could not be aſcertained.

24. In the ſame manner, 11 grains of *copper* were diſſolved in 100 grain-meaſures of impregnated oil of vitriol. The ſolution was of a deep violet colour, and at laſt was turbid. The quantity of nitrous gas, expelled into the inverted jar during the operation, was 4700 grain-meaſures. When the copper was removed, and 200 grains of water were added to the ſolution, an effervefcence took place; 1700 grain-meaſures of nitrous

gas

gas were expelled, and the ſolution then acquired a blue colour.

25. In the ſame apparatus, and manner, 100 grain-meaſures of the impregnated oil of vitriol were applied to tin, which was thereby diminiſhed in weight 16 grains, while the liquor acquired a violet colour, became turbid by the ſuſpenſion of the calx of tin, and a quantity of nitrous gas was thrown into the inverted receiver, equal to 4100 grain-meaſures, without application of heat, and another quantity equal to 4900 grain-meaſures, after the retort was put into the water-bath.

26. *Mercury* added to the impregnated oil of vitriol formed a thick, white, turbid liquor, which was rendered clear by addition of unimpregnated oil of vitriol. In a little time this mixture, continuing to act on the remaining mercury, acquired a purple colour. The mercury acted upon ſunk to the bottom of the glaſs, in the form of a white powder; and the purple liquor, when mixed with a ſolution of common ſalt in water, gave no appearance of its containing any mercury in a diſſolved ſtate.

 27. The

27. The nitrous gas, with which the oil of vitriol is impregnated, shews no disposition to quit the acid by exposure to air; but, on adding water to the impregnated acid, the gas is expelled suddenly, with great effervescence, and with red fumes, in consequence of its mixture with the atmospherical air.

Upon adding 240 grains of water to 60 grain-measures of impregnated oil of vitriol, 2300 grains of nitrous gas were thrown into the receiver; but, as the action of the two liquors is instantaneous, the quantity of gas expelled from the retort, before its neck could be immersed in water, and placed under the receiver, must have been considerable. The whole of the gas, however, was not extricated by means of the water; for, the remaining liquor dissolved 5 grains of copper, while 800 measures of nitrous gas were thrown into the retort.

28. The following facts, principally, are established by the preceding experiments.

First. That a mixture of the vitriolic and nitrous acids, in a concentrated state, has a peculiar faculty of dissolving silver copiously.

Secondly,

Secondly. That it acts upon, and principally calcines, tin, mercury, and nickel; the latter of which, however, it diſſolves in ſmall quantity; and that it has little or no action on other metals.

Thirdly. That the quantity of gas produced while the metal is diſſolving is greater, relatively to the quantity of metal diſſolved, when the proportion of nitre to the vitriolic acid is ſmall than when it is large; and that, when the metals are diſſolved by mixtures containing much nitre, and with a ſmall production of gas, the ſolution itſelf, or the metallic ſalt formed in it, yields abundance of gas when mixed with water.

Fourthly. That dilution with water renders the concentrated mixture leſs capable of diſſolving ſilver, but more capable of acting on other metals.

Fifthly. That this mixture, of highly concentrated vitriolic and nitrous acid, acquires a purple or violet colour when phlogiſticated, either by addition of inflammable ſubſtances, as ſulphur, or by its action on metals, or by very

ſtrong impregnation of oil of vitriol with nitrous gas *.

Sixthly. That this phlogiſtication was found to communicate to the mixture the power of diſſolving, though in ſmall quantities, copper, iron, zinc, and regulus of cobalt.

Seventhly. That water expels from a highly-phlogiſticated mixture of concentrated vitriolic and nitrous acids, or of oil of vitriol impregnated with nitrous gas, a great part of its contained gas; and that therefore this gas is not capable of being retained in ſuch quantity by dilute as by concentrated acids. Water unites with the mixture of oil of vitriol and nitre, without any conſiderable effervefcence.

29. To theſe obſervations I ſhall ſubjoin one other fact, namely, that, when to the mixture of oil of vitriol with nitre a ſaturated ſolution of common ſalt in water is added, a powerful aqua

* Dr. Prieſtley has noticed this colour communicated to oil of vitriol by impregnation with nitrous gas or vapour, and alſo the effervefcence produced by adding water to this impregnated liquor. See Experiments and Obſervations, Vol. III. p. 129 and 217.

regis

regis is produced, capable of diſſolving gold and platina; and this aqua regis, though compoſed of liquors perfectly colourleſs, and free from all metallic matter, acquires at once a bright and deep yellow colour. The addition of dry common ſalt, to the concentrated mixtures of vitriolic and nitrous acids, produces an efferveſcence, but not the yellow colour; for the production of which a certain proportion of water ſeems to be neceſſary.

PART II.

On the Precipitation of Silver from nitrous Acid by Iron.

SECTION I.

1. Bergman relates *, that upon adding iron to a ſolution of ſilver in the nitrous acid no precipitation enſued; although the affinity of iron to acids in general is known to be much ſtronger than that of ſilver; and although, even with regard to the nitrous acid, other experiments evince

* Diſſert. de Phlog. quantitate in Metallis.

the

the ſuperior affinity of iron; for, as iron precipitates copper from this acid, and as copper precipitates ſilver, we muſt infer the greater affinity of iron than of ſilver. In the courſe of his experiments, however, ſome inſtances of precipitation occurred, which he attributed to the peculiar quality of the irons which he then employed *. I was

* Bergman tried many different kinds of iron, and he thought he found two which were capable of precipitating ſilver. But, as he did not diſcover the circumſtances according to which this precipitation ſometimes does, and at other times does not, happen, he may have been miſtaken with regard to the peculiar quality of theſe two kinds of iron; at leaſt the ſeveral kinds which I have tried always precipitated ſilver in certain circumſtances, and always failed to precipitate it in certain other circumſtances. I do not know any other author who has mentioned this ſubject, excepting Mr. Kirwan; who, in the concluſion of his valuable papers on *the attractive powers of mineral acids*, ſays, "I have always found ſilver "to be eaſily precipitated from its ſolution in the nitrous "acid by iron, the ſum of the quieſcent affinities being 625, "and that of the divellent 746. Yet Mr. Bergman obſerved, "that a very ſaturated ſolution of ſilver was very difficultly "precipitated, and only by ſome ſorts of iron, even though "the ſolution was diluted, and an exceſs of acid added to it. "The

I was deſirous of diſcovering the circumſtances, and of inveſtigating the cauſe, if I ſhould be able, of this irregularity and exception to the generally received laws of affinity.

"The reaſon of this curious phænomenon appears to me de-"ducible from a circumſtance firſt obſerved by Scheele in "diſſolving mercury, namely, that the nitrous acid, when "ſaturated with it, will take up more of it in its metallic "form. The ſame thing happens in diſſolving ſilver in the "nitrous acid in a ſtrong heat; for, as I before remarked, "the laſt portions of ſilver thrown in afford no air, and con-"ſequently are not dephlogiſticated. Now this compound, "of calx of ſilver and ſilver in its metallic form, may well "be unprecipitable by iron; the ſilver in its metallic form "preventing the calx from coming into contact with the iron, "and extracting phlogiſton from it." In this paper I ſhall not enter into the explanation of theſe appearances; but I thought it neceſſary to premiſe what ſo eminent a chemiſt as Mr. Kirwan has ſuggeſted on the ſubject, that the reader may ſee at once the preſent ſtate of the queſtion. I ſhall only remark that the above explanation, not being founded on any peculiarity in the nature of iron, ſeems to ſuppoſe, that the ſilver is alſo incapable of being precipitated, from ſuch ſolutions as iron cannot act upon, by any other metal. But this is not the caſe: copper and zinc readily precipitate ſilver from theſe ſolutions.

2. I digeſted a piece of fine ſilver in pure and pale nitrous acid, and, while the diſſolution was going on, and before the ſaturation was completed, I poured a portion of the ſolution upon pieces of clean and newly-ſcraped iron wire in a wine-glaſs, and obſerved a ſudden and copious precipitation of ſilver. The precipitate was at firſt black, then it aſſumed the appearance of ſilver, and was five or ſix times larger in diameter than the piece of iron wire which it enveloped. The action of the acid on the iron continued ſome little time, and then it ceaſed; the ſilver was re-diſſolved, the liquor became clear, and the iron remained bright and undiſturbed in the ſolution at the bottom of the wine-glaſs, where it continued during ſeveral weeks, without ſuffering any change, or effecting any precipitation of the ſilver.

3. When the ſolution of ſilver was completely ſaturated, it was no longer affected by iron, according to Bergman's obſervation.

4. Having found that the ſolution acted on the iron, and was thereby precipitated, before it had been

been ſaturated, and not afterwards, I was deſirous of knowing, whether the *ſaturation* was the circumſtance which prevented the action and precipitation. For this purpoſe, I added to a portion of the ſaturated ſolution ſome of the ſame nitrous acid, of which a part had been employed to diſſolve the ſilver; and, into this mixture, abounding with a ſuperfluous acid, I threw a piece of iron, but no precipitation occurred. It was thence evident, that the ſaturation of the acid was not the only circumſtance which prevented the precipitation.

TO BE CONCLUDED IN OUR NEXT.

XXXVI. *Experiments to diſcover what kind of Steel is moſt fit for receiving the magnetic Power; by* M. Brisson.

From the Memoirs of the Academy of Sciences of Paris.

PHILOSOPHERS have taken great pains, and made many experiments, to find out the beſt manner of touching bars of ſteel, ſo as to convert them into artificial magnets; but I know not that any one has ſought to diſcover, by comparative experiments with different kinds of ſteel, what kind is moſt proper for this purpoſe, that is, what kind is capable of receiving the greateſt quantity of magnetic power. I have employed myſelf in making ſome experiments upon this ſubject, and ſhall now give an account of them to the Academy.

I cauſed

I caused five pairs of bars, of different kinds of steel, to be made by a very good workman, who knows perfectly well how to work in steel, and how to temper it. They are all exactly equal to each other in length, in width, in thickness, and even, except a few grains, in weight; they are also, as near as could be, equally well wrought and polished, and all tempered as hard as possible. Each of these bars is six inches and three quarters of a line in length, six lines wide, and two lines thick.

I placed them in pairs, according to Dr. Knight's method, keeping them separate by a slip of wood, and making them communicate at each of their extremities, by the contact of a piece of soft iron, nine lines in width.

That I might know them from each other, I marked each of them with a different figure.

The bars marked 1 are of English cast steel; and weigh, both together, five ounces, four drachms, and fifty-one grains.

The bars marked 2 are of cast steel of Amboise, and weigh, together, five ounces, four drachms, fifty-seven grains and a half.

The

The bars marked 3 are of common ſteel of Amboiſe, and weigh, together, five ounces, four drachms, forty-ſix grains and a half.

The bars marked 4 are of German ſteel, known by the name of *Etoffe de Pons*, and weigh, together, five ounces, four drachms, and fifty-three grains.

The bars marked 5 are of Engliſh ſteel, and weigh, together, five ounces, four drachms, and forty grains.

I have two pairs of bars, ſeventeen inches and ſix lines long, one inch wide, and ſix lines thick; their magnetic power is very ſtrong, and I quicken that power, by touching them alternately one with the other. With one of theſe pairs of bars I touched all the five pairs above-mentioned; in doing that I conſtantly uſed the ſame pair, which I took care to have always in the ſame good ſtate; that is to ſay, I retouched them every time with the other great pair; that I might, as far as was poſſible, have all circumſtances alike, and not have reaſon to ſuſpect any difference between the five kinds of ſteel, except their different diſpoſition or capability to receive the magnetic power.

I touched

I touched all theſe bars according to the manner of M. Antheaume: I placed them all, pair by pair, connected by the piece of ſoft iron before-mentioned, and ſeparated by a ſlip of wood, in the direction of the magnetic meridian; and, in order to touch them, I placed my two great bars end to end, with their contrary poles towards each other, and ſeparated only by a card thrice doubled. I then let them ſlide gently five times backwards and forwards, from one end to the other of each of the bars, upon each of their broad ſurfaces, but without going beyond their extremities, and always beginning and leaving off in the middle of the bar.

Theſe bars having been touched in the above-mentioned manner, I endeavoured to find out their power of attraction. For that purpoſe I faſtened each pair together by means of two bands of copper; each band having a ſcrew to tighten it, one of which ſcrews had a ring to it, by which the bars might be hung up. At the upper end, the bars were connected by the piece of iron already mentioned: at the lower end,

instead of such a piece, I placed a ring of soft iron, rounded in such a manner as to touch the bars only by a narrow line. To this ring was adapted a hook, intended to receive the handle of a little tin bucket in which the weights were put.

Every thing having been thus disposed, I successively, and gradually, loaded each pair of bars with grains of lead, till the iron ring separated from the bars. I took care, however, not to load them in this manner, till the ring had adhered to the bars for the space of twenty-four hours.

The following is the result of these experiments:

The bars marked 1, of English cast steel, which weigh, together, five ounces, four drachms, and fifty-one grains, sustained, including the weight of the ring, two pounds, thirteen ounces, and five drachms; which is somewhat more than eight times their own weight.

The bars marked 2, of cast steel of Amboise, which weigh, together, five ounces, four drachms, fifty-seven grains and a half, sustained, including the weight of the ring, one pound, twelve ounces,

two

two drachms, and thirty-ſix grains; which is rather more than five times their own weight.

The bars marked 3, of common ſteel of Amboiſe, which weigh, together, five ounces, four drachms, forty-ſix grains and a half, ſuſtained, including the weight of the ring, five ounces, ſeven drachms, and fifty-ſeven grains; which is, as is obvious, only a little more than their own weight.

The bars marked 4, of German ſteel, known by the name of *Etoffe de Pons*, which weigh, together, five ounces, four drachms, and fifty-three grains, ſuſtained, including the weight of the ring, four pounds, three ounces, three drachms, and three grains; which is rather more than twelve times their own weight.

The bars marked 5, of Engliſh ſteel, which weigh, together, five ounces, four drachms, and forty grains, ſuſtained, including the weight of the ring, four pounds, fifteen ounces, one drachm, and thirty-ſix grains; which is more than fourteen times their own weight.

From the foregoing experiments it appears:

First. That English steel is the most fit for receiving the magnetic power, and that it ought to be preferred to every other kind.

Secondly. That the German steel, known by the name of *Etoffe de Pons*, is the next in goodness to English steel; its power being only one seventh less than that of English steel.

Thirdly. That cast steel ought never to be used for making artificial magnets; because it is capable of receiving but little magnetic power, in comparison with the others.

XXXVII.

XXXVII. *Defcription of the Machine for kneading Dough, ufed at the public Baking-houfes of Genoa* *.

WITH A PLATE.

From the TRANSACTIONS of the PATRIOTIC SOCIETY of MILAN.

THE object of this machine is to make a great quantity of flour into dough; and to knead that

* It may not be improper to inform our readers that, at Genoa, bread is not allowed to be made for fale, except at the public baking-houfes of the city, and under the infpection of the magiftrates; and that the workmen were formerly accuftomed to knead the dough with their naked feet. In the volume from which the following account is extracted, (publifhed in 1789,) the machine about to be defcribed is faid to have been in ufe *many* years; but a late traveller, Dr. James Edward Smith, in his Tour on the Continent, (Vol. III. p. 99,) complains that the difgufting-cuftom above mentioned ftill continued in the year 1797, he having been, in that year, an eye-witnefs of it.

dough as completely as may be neceſſary, with a great ſaving of time and labour.

From the annexed figures (ſee Plate XVI.) a clear idea of the machine may be obtained; the various parts of which, marked with their reſpective letters, we ſhall here briefly explain.

A, Fig. 1, is a frame of wood, which ſupports the axis of the machine; a wall, 14 palms * high from the ground, may be made uſe of inſtead of this frame.

B, a wall, three palms and a half thick, through which the aforeſaid axis paſſes.

C, another wall, ſimilar to the former, and facing it, at the diſtance of twenty-one palms.

D, the axis, thirty palms in length, and one palm and one third in thickneſs.

E, the great wheel, fixed to the aforeſaid axis, between the frame and the wall; its diameter is twenty-eight palms; and its breadth, which is capable of holding one or two men, is five palms.

* The meaſures are given in palms of Genoa, the proportion of which, to Paris feet, is ſaid to be as 771 to 1000.

F, ſteps,

F, ſteps, by treading on which the men turn the wheel with great velocity; they are two palms daſtant from each other, and one-third of a palm in height.

G, a ſmaller wheel, with cogs, fixed almoſt at the extremity of the axis. Its diameter is twelve palms and a half.

H. a piece of wood, or beam, which extends from one wall to the other; it is twenty-one palms long, and one palm and one third thick. A ſimilar beam (not ſeen in the figure) is on the oppoſite ſide.

I, a croſs piece of wood, placed near the wall C; it is fixed in the two beams, and ſerves to ſupport the other extremity of the axis. Its length is fourteen palms, and its thickneſs one palm and one third: there is alſo a croſs piece, (which cannot be ſeen in the figure,) fourteen palms long, and half a palm thick, placed cloſe to the wall B.

K, a ſtrong piece of oak, curved and fixed croſs-ways in the forementioned beams, to receive the axis of the trundle. Its length is fourteen palms, its thickneſs one and a half.

L, a trundle, moved by the cogged wheel G, five palms and a half in diameter, and one palm and a quarter in height.

M, an axis, proceeding from the trundle L, and continued through the croſs N, to the bottom of the tub P; its centre is made of iron, partly ſquare and partly round, and it turns in a ſocket of braſs. The firſt part of this axis, between the trundle L and the croſs N, is of ſquare iron, ſurrounded by two pieces of wood, held together by iron hoops, which may be removed at pleaſure, to examine the iron within: its length is three palms, its diameter about one palm. The ſecond part of the axis, which is within the tub, is made like the firſt part: its height is one palm and a half, its diameter one palm and one ſixth. The wooden ſheath of this part of the axis is fixed to t e bottom of the tub, by means of three ſcrews with their nuts. This axis is one third of a palm diſtant from the neareſt triangular *beater* of the croſs.

N, a croſs, formed of two bars of wood unequally divided, ſo that the four arms of the croſs are of different lengths. One of the two

pieces

pieces of wood, of which the cross is made, is six palms in length, the other five palms. Their thickness is seven-twelfths of a palm, and their breadth one palm.

O, four pieces of wood, called *beaters*, of a triangular shape, fixed into the extremity of, and underneath, the arms of the abovementioned cross; consequently they beat or knead the dough in the tub at unequal distances from the centre: they are one palm and three quarters in length, or height, and half a palm in thickness. Other views of these, and of the neighbouring parts, are given in Figs. 3 and 4.

P, a stout tub of wood, about one quarter of a palm thick; and well hooped with iron. Its diameter is six palms, its height one palm and a half, in the clear.

Fig 2, a box or trough of wood, four palms long, and three palms wide, in which the leaven is formed (in about an hour) in a stove, and in which it is afterwards carried to the tub P.

Fig. 3, view of the trundle, cross, &c. with a section of the tub.

Fig. 4, bird's-eye-view of the cross and tub.

Manner

Manner of uſing the above-deſcribed Machine.

From what has been ſaid it is eaſy to conceive that the men, by walking in the wheel E, cauſe the *beaters* O to turn round, and theſe mix, break, and knead, the dough, placed in the tub P.

This tub will contain eighteen *rubbi* of flour, which is carried to it in barrels; the leven is then carried to it in the box or trough, Fig. 2; and, when the whole is tempered with a proper quantity of warm-water, the wheel is turned round; by which the dough is properly and completely kneaded. In general a quarter of an hour is ſufficient to make very good dough, but an experienced baker, who ſuperintends, determines that the operation ſhall be continued a few minutes more or leſs, according to circumſtances.

Printed by John Nichols, *Red Lion Paſſage, Fleet-Street, London.*

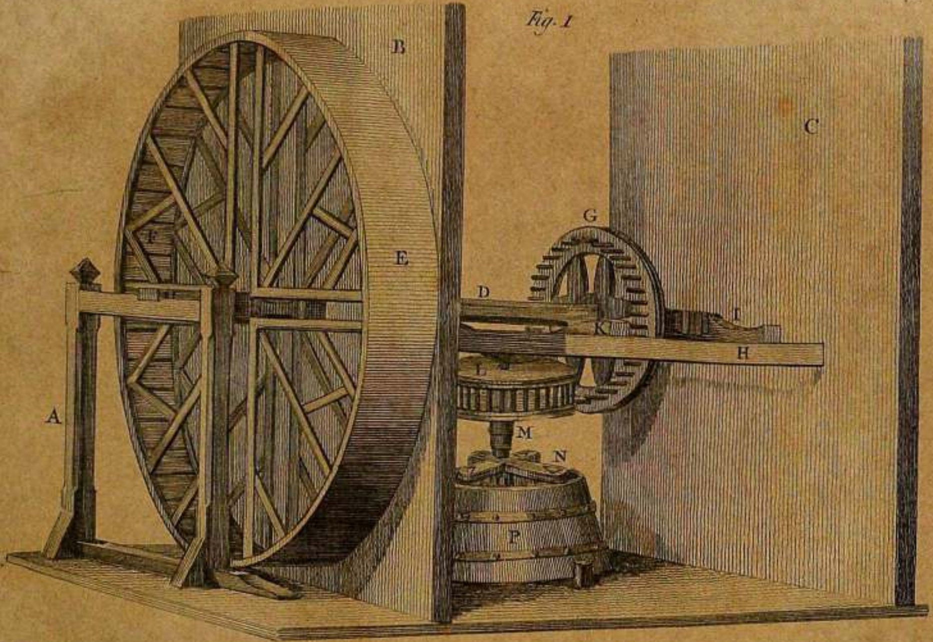


Fig. 1

Fig. 2

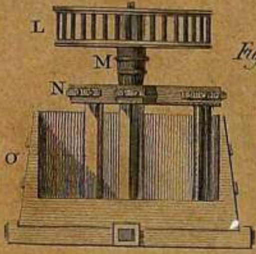


Fig. 3

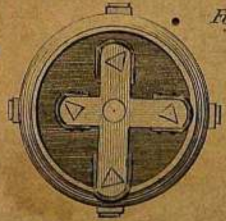


Fig. 4

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XVII.

XXXVIII. *Specification of the Patent granted to* HENRY CORT, *of Funtly Iron-Mills, in the Parifh of Titchfield, in the County of Southampton, Efq. for his Method and Procefs of preparing, welding, and working, various Sorts of Iron, and of reducing the fame into Ufes, by Machinery, a Furnace, and other Apparatus.*

Dated Jan. 17, 1783.

TO all to whom thefe prefents fhall come, &c. Now KNOW YE, that I the faid Henry Cort, in conformity to the faid letters patent, and according to a provifo therein contained for that purpofe,

have deſcribed and aſcertained, and by theſe preſents do deſcribe and aſcertain, the nature of my ſaid invention, and in what manner the ſame is to be performed: that is to ſay, for large uſes, ſuch as ſhanks, arms, rings, and palms of anchors, mooring and bridle chain links, and the like, (in the doing of which I work with a forge-hammer,) various ſorts of iron are prepared, welded, and worked, according to the ſaid invention, in the manner beſt ſuited to each particular uſe, as follows. For inſtance, when a chain link, anchor-ring, or other long piece of iron of equal ſize at both ends, is to be wrought from one faggot, I cauſe bar iron, of ſufficient lengths, to be cloſely faggoted together; and the beſt method of doing this I have found by experiment to be by laying a flat bar, of the width and length required, at the bottom; upon which four ſquare bars are to be placed, in regular order; and upon the top, and at each ſide, other flat bars perfectly incloſing the four ſquare bars, and thereby making the faggot ſquare; the ſize of all which bars is to be proportionate to each other, as well as to the uſe intended to be finiſhed from them, and the fag-

got

got ſo formed is to be bound together, as cloſe as poſſible, by ſquare collars driven on tight. But, when the uſe intended is of conſiderable length, and tapering, ſo as to be ſmaller at one end than the other, like the ſhank or arm of an anchor, to be wrought in its whole length from one faggot, I find that the ſame may be beſt and moſt conveniently formed by flat bars, forged on purpoſe gradually tapering, ſo as to be thinner and narrower at one end than at the other; the proportions of ſuch bars being calculated to correſpond with the dimenſions of the reſpective parts of the uſes to be finiſhed from them; and, in preparing ſuch faggots, theſe flat bars are laid over one another, in the manner of bricks, in building, ſo that the upper bars every where cover the joints of thoſe underneath; one bar, wider than thoſe which compoſe the body of the faggot, being laid at the bottom, and another of the ſame width at the top; by which means the faggot, when taken from the furnace, is more eaſily reſted on the anvil, and ſo placed as to receive the better impreſſion from the firſt ſtrokes of the hammer, whereby it becomes more perfectly welded. And

 I ob-

I obſerve the ſame method, as nearly as poſſible, in laying old hoops together on the bundling-bench, as herein after mentioned, and in preparing and faggoting all other ſorts of iron for the welding-furnace, as far as the ſhape of ſuch iron, and of the uſes intended to be finiſhed from the ſame, will allow. Several of the faggots ſo prepared, to the amount (for inſtance) of half a ton, more or leſs, are put at once into a common air-furnace, uſually denominated a balling-furnace, and therein brought to a welding heat at the ſame time, which in my furnace is completed with great ſpeed and diſpatch; and this is a practice not hitherto uſed in any chafery or hollow fire, or other fire blown by blaſt, in welding large faggots of iron; and thus to take welding heats in a balling-furnace, according to the method and proceſs herein ſpecified, is part of my invention. If the whole length of the faggots, when prepared, is too much to admit of being introduced entire into the furnace, the faggots may be firſt put in at one end, and, the other end remaining out, the door is to be let down upon them, and cloſed at the bottom with ſand;

and afterwards, the effects of the firſt heat being produced, the other ends are heated in like manner. But, for the ſhanks of large anchors, made entire in one length, and other faggoted iron of great length, for inſtance, of more than eight or ten feet long, then, in order to take the welding heat in the middle, a door is made in the back of the furnace, directly oppoſite to the one in front, and the ends firſt welded being put through the furnace, and out at that door, the ſame is let down and cloſed with ſand, in like manner as the front door, and the middle part only of the iron confined to the heat of the furnace. But, for thoſe purpoſes which require ſuch a length, the mode I prefer is to weld the iron in two pieces, and afterwards to ſhut it together with ſcarfs of three or four feet long, according to the plan herein after more particularly deſcribed. But, in the furnace uſed after the manner above mentioned, a welding heat may be taken much ſooner than in a hollow fire, and that in lengths (for inſtance) of four feet or more at one time; and, when the heat is perfect, the faggots or pieces are heated and brought, either one by one, or two, or

more,

more, to be welded together, as the caſe may require, under a forge hammer of great weight, for example, of eight hundred or nine hundred weight, more or leſs, the ſurface of which, and the anvil under it, is of ſufficient dimenſions, for example, of eighteen or twenty inches, more or leſs, in length, and about ten inches wide, except at the points, which are made narrow for the purpoſe of drawing the iron out; and, by a few ſtrokes of this hammer (which acts with great velocity) ſtriking on each ſide of the faggot, (whilſt the heat remains perfect,) the whole length heated is welded, round to the centre, into one ſolid maſs of iron. For ſquare uſes, or thoſe in which only the angles are beat down, in finiſhing after the faggot is welded, the hammer and anvil juſt deſcribed, with plain ſurfaces, are the fitteſt to be applied; but, for uſes that are to be made round, ſuch as anchor-rings, and the like, I work them at an anvil with a ſemicircular groove, and ſometimes alſo by a hammer with a ſimilar groove. When faggots are too heavy to admit of this operation being performed by hand, a crane is neceſſarily uſed, but two good forge-men can manage a faggot of

three

three hundred weight in hand, by the aſſiſtance of others, with bars, in lifting it from the furnace to and upon the anvil, and perform the work in general, better than by the crane. And I find it to be the beſt way of making ſhanks for large anchors, to lay and weld them in two pieces, one of the faggots being calculated for the ſquare, and the other for the round part; and, after theſe are drawn out ſeparately, to ſhut them together, under the ſaid heavy hammer, with a ſcarf of ſufficient length, for inſtance, of three or four feet long, by a welding heat in the furnace. Theſe ſhuts are much longer than thoſe uſually taken in a hollow fire or chafery; and, being perfectly ſound, the anchors are altogether as ſtrong, and more neatly finiſhed, than thoſe for which the faggots are at firſt formed of the entire length of the ſhank. I alſo remark that, by a welding heat from the furnace, palms may be brought on the arms of anchors, under the forge-hammer, with greater certainty, and better effect, than by the methods in practice before my invention. If, inſtead of bar-iron, to be welded for the purpoſes as above ſtated, old hoops, or other ſuch like iron,

are to be ufed, the fame are to be cut with the mill-fhears, or otherwife, or folded up into proper lengths for the intended ufes, and then to be faggoted together by means of the common bundling-bench, or by being driven into collars of the fize and fhape required; in both which cafes I caufe them to be laid, as nearly as poffible, in the form herein before fpecified with refpect to bars of iron, fo that the hoops of the upper layers cover the joints of the under ones, and, a welding heat being taken on thefe, they are at once welded, and drawn out to convenient dimenfions, under the large hammer. And, for purpofes that require two or more of thefe to be welded together, as fhanks and arms, or bodies and palms, of anchors, or mooring and bridle-chain links, and the like, they are firft fhingled found apart, and then either returned into the fame furnace, or (which I find better in works fufficiently large) put into another furnace of the fame kind; and, being again heated to a welding heat, two of them are welded found together, and drawn to the proper dimenfions, and fhape, and a third, and fourth, and fo on, may be afterwards

fhut

ſhut on in like manner; after which the whole is neatly finiſhed under the large hammer, without the uſe either of chafery or hollow fire. And I find that the large uſes thus finiſhed by me are, in all reſpects, poſſeſſed of the higheſt degree of perfection. I alſo have found that the fire in the balling furnace is better ſuited, from its regularity and penetrating quality, to give the iron a perfect welding heat throughout its whole maſs, without burning in any part, than any fire blown by a blaſt; inſomuch that if bar, or other maſſy iron, is bound into a faggot of five or ſix inches diameter, by an old caſk-hoop, the ſixteenth part of an inch in thickneſs, the one will acquire a complete welding heat, and the other not be burnt or waſted; and the conſequence of this is, that whereas bar-iron, faggoted and made into anchors, and other large uſes, in the uſual method practiſed by anchor-ſmiths, is not welded to the centre, but rather covered only with an incruſtation of welded iron, (when the anchors and ſuch other uſes made by them are completely finiſhed,) and conſequently is liable to decay, and many ac-

 cidents,

cidents; the ſame large uſes, prepared by my method, whether from bars or from ſmaller iron, are equally ſolid through every part, and muſt neceſſarily be ſtronger, as well as leſs liable to injury, than iron not ſo perfectly compreſſed; and the whole maſs may, in one welding heat, thus managed, be drawn out more or leſs in the rollers together, become at once welded into one ſolid body, and meliorated into good tough iron, without being previouſly cleanſed in the ſcouring barrel, or otherwiſe. If the iron to be welded by this method is intended for plates of any kind, it is bundled or laid together, before being put into the furnace, in the ſhape and ſize beſt ſuited to the uſe for which ſuch plates are intended, and paſſed repeatedly through the common rolling and ſlitting-mill rollers, with flat ſurfaces, till it acquires the requiſite degree of thickneſs. If it is intended for flat or ſquare bars, rods, hoops, or the like, as ſoon as welded, and made ſufficiently thin under the rollers, it may at the ſame heat be paſſed through the ſlitters, and from them again through the rollers, if needful, for

proper uſes. When the iron thus to be welded through the rollers is deſigned for bars, half flats, or thimble iron, with feather edges, a groove of the requiſite dimenſions is made in the under roller, through which groove the iron is to be paſſed, in the ſtate of welding heat. In caſe thick bars, or ſquares, or round bolts, are intended to be welded through the rollers, grooves of the ſhape and dimenſions required for any of thoſe uſes are made in the under roller, and collars on the upper roller, to work exactly within ſuch grooves; the ſurface of ſuch collars being either plain for ſquares and flats, or concave for bolts and the like, as the caſe may require. Much of the ſucceſs of theſe operations depends on the iron being properly cut, faggoted, bundled, or placed together, if large; or being put into coffins, as before deſcribed, ſuited to the intended purpoſe, if it conſiſts of ſcraps, before being carried into the furnace. But this circumſtance being attended to, and the coffins of ſcraps, and even piles of the ſame, as well as faggots of ſuitable dimenſions, being paſſed through any of the ſaid grooves, pro-

 duce

duce the intended uſe perfectly welded at the edges, and throughout; and, in mills of ſufficient power, with rollers large enough to admit of grooves and collars for the purpoſe, very great ſized iron may be welded in this manner as well as under the hammer, the heat being the ſame in both caſes; which proceſs is my own invention, and put in uſe by me only. I have made faggots of inferior bar-iron, five inches in diameter, and, paſſing the ſame through the groove in the rollers, have found them completely welded at the ſides, without a crack, into one maſs, perfectly ſound to the centre, and improved in quality. In like manner, old mooring chain links, ſhips knees, and other iron, decayed and eaten by ruſt, being cut into proper lengths, duly heated, and paſſed through the rollers, will produce exceeding good iron, without any other proceſs. Another proceſs relates to the management of ſcull and caſt iron; the ſcull-iron being firſt piled together in heaps, upon old plate or bottoms, for example, of about three quarters of an hundred weight more or leſs each, is ſhingled, and drawn down by the

forge-

forge-hammer, from the balling furnace, into the ſhape and form required for the uſe intended; in one heat after which it is again heated to a welding heat in the furnace, and paſſed under the rollers, for any of the purpoſes herein before deſcribed, which makes good iron without the uſual proceſs of refining with charcoal or coke. Pig and ſow metal, commonly called caſt-iron and old caſt-iron, is to be ſunk down in the finery into half blooms, and ſhingled under the forge-hammer to the intended ſize of the uſe, in one heat, inſtead of being drawn into anconies; after which it undergoes a like proceſs, by welding under the rollers, whereby it is perfectly refined, and at the ſame time reduced, either by the ſaid rollers, or by being paſſed from them through the cutters, to the uſes required: or both of theſe kinds of iron may be prepared for the furnace by methods now practiſed, and then ſhingled, and welded to uſes in one heat under the rollers, in the method herein above ſpecified with reſpect to ſcrap-iron. All which iron, prepared, welded, worked, and reduced into uſes, by the methods

and

and proceſſes before ſet forth, will be equal, if not ſuperior, in quality to iron made by the ordinary proceſs, or methods before in practice. And the nature of my ſaid invention, ſo performed by the ſaid methods and proceſſes, herein before ſet forth, eſpecially conſiſts in taking a welding heat on ſeveral pieces or parcels, and faggots of iron, in the ſame furnace at one time, and drawing the ſame into uſes, either ſingly, or by welding and ſhutting two or more together by the operations deſcribed, either under the forge-hammer or through the mill-rollers, as may beſt ſuit the uſe intended; and theſe operations may be diverſified, ſo as to ſuit all purpoſes whatever, to which forged or welded iron is or can be applied, as well as thoſe herein particularized by way of example. In witneſs whereof, &c.

XXXIX. *Specification of the Patent granted to Mr.* James Playfair, *of Ruſſell Place, in the Pariſh of St. Pancras, Architect; for his Method of conſtructing Locks for navigable Canals, on Principles entirely new, and alſo of improving thoſe already erected, whereby any given Portion of the Water, in the Aſcent and Deſcent of Veſſels, is ſaved.*

WITH TWO PLATES.

Dated July 5, 1791.

To all to whom theſe preſents ſhall come, &c. Now know ye, that, in compliance with the ſaid proviſo, I the ſaid James Playfair do hereby declare, that the ſaid invention is deſcribed in the plan and deſcription thereof hereunto annexed.

Specification of the nature of, and manner of conſtructing, canal locks, for the purpoſe of ſaving water, and for enabling engineers, or others, to make uſe of locks of different depths, upon the ſame chain of locks, without uſing more water than if the locks were all of one depth. The

nature and principle of this manner of ſaving water conſiſt in letting the water, which has ſerved to raiſe or fall a boat or barge from the lock, paſs into reſervoirs or ciſterns, whoſe apertures of communication with the lock are upon different levels, and which may be placed or conſtructed at the ſide or ſides of the lock with which they communicate, or in any other contiguous ſituation that circumſtances may render eligible; which apertures may be opened or ſhut at pleaſure, ſo that the water may paſs from the lock to each reſervoir of the canal, or from each reſervoir to the lock, in the following manner. The water which fills the lock, when a boat is to aſcend or deſcend, inſtead of being paſſed immediately into the lower part of the canal, is let paſs into theſe ciſterns or reſervoirs, upon different levels; then, their communications with the lock being ſhut, they remain full until another veſſel is wanted to paſs; then again the ciſterns are emptied into the lock, which is thereby nearly filled, ſo that only the remainder which is not filled is ſupplied from the higher part of the canal. Each of theſe ciſterns muſt have a ſurface not leſs than that of the lock, and muſt contain

contain half as much water as is meant to be expended for the paſſing of each veſſel. The ciſtern the moſt elevated is placed twice its own depth (meaſuring by the aperture, or communicating opening of the ciſterns,) under the level of the water in the higher part of the canal. The ſecond ciſtern is placed once its own depth under the firſt, and ſo on are the others, to the loweſt; which laſt is placed once its own depth above the level of the water in the lower part of the canal. The apertures of the intermediate ciſterns, whatever their number may be, muſt all be equally divided into different levels; the ſurface of the water in the one being always on the level of the bottom of the aperture of the ciſtern which is immediately above. As an example of the manner and rule for conſtructing theſe ciſterns, which it is my duty and deſire to render as clear as poſſible, ſuppoſe that a lock is to be conſtructed twelve feet deep, that is, that the veſſel may aſcend or deſcend twelve feet in paſſing. Suppoſe the lock ſixty feet long, and ſix feet wide, the quantity of water required to fill the lock, and to paſs a boat, is 4320 cubic feet; and ſuppoſe that, in

in calculating the quantity of water that can be procured for ſupplying the canal, after allowing for waſte, it is found (according to the number of boats that may be expected to paſs) that there will not be above eight hundred cubic feet for each, then it will be neceſſary to ſave five-ſixths of the whole quantity that in the common caſe would be neceſſary; to do which ten ciſterns muſt be made, (the mode of placing which is expreſſed in the drawing, Fig. 2. Plate XVIII.) each of which muſt be one foot deep, or deeper at pleaſure, and each muſt have a ſurface of three hundred and ſixty feet ſquare, equal to the ſurface of the lock. The bottom of the aperture of the loweſt ciſtern muſt be placed one foot above the level of the water in the lower part of the canal, or eleven feet under the level of the high water; the ſecond ciſtern muſt be two feet above the level of the low water; the third three feet, and ſo on of the others; the bottom of the tenth, or uppermoſt ciſtern, being ten feet above the low water, and two feet lower than the high water; and, as each ciſtern muſt be twelve inches in depth, the ſurface of the water in the higher ciſtern will be one foot under the

level

level of the water in the upper part of the canal. The ciſterns being thus conſtructed, when the lock is full, and the boat to be let down, the communications between the lock and the ciſterns, which until then have all been ſhut, are to be opened in the following manner: firſt, the communication with the higher ciſtern is opened, which, being at the bottom two feet under the level of the water in the lock, is filled to the depth of one foot, the water in the lock deſcending one foot alſo at the ſame time; that communication is then ſhut, and the communication between the lock and the ſecond ciſtern is opened; one foot more of the water then paſſes into that ciſtern from the lock, and fills it; the opening is then ſhut: the ſame is done with the third, fourth, fifth, ſixth, ſeventh, eighth, ninth, and tenth ciſterns, one by one, until they are all filled; and, when the tenth, or lowermoſt ciſtern, is filled, there remains but two feet depth of water in the lock. The communication between the lock and the lower part of the canal is then opened, and the laſt two feet depth of water is emptied into the lower part of the canal. By this means it is

evident that, inſtead of twelve feet depth of water being let deſcend into the lower part of the canal, there is only two feet depth that deſcends, or one-ſixth of the whole; therefore, inſtead of 4320 cubic feet being uſed, there are only 720 cubic feet uſed: the remainder of the water in the ciſterns being uſed as follows. When another boat is to mount, the ſluices being then ſhut, and the boat in the lock, the tenth or lowermoſt ciſtern is emptied into the lock, which it fills one foot; the communication being then ſhut, the next loweſt ciſtern, or the ninth, is emptied into the lock, which is thereby filled another foot; and ſo, in like manner, all the other ciſterns are emptied one after another, until the higher ciſtern being emptied, which fills the tenth foot of water in the lock, there remains but two foot of water to fill, which is done from the upper part of the canal, by opening the higher ſluice to paſs the boat; by that means, the ſame quantity of water deſcends from the upper part of the canal into the lock, that in the other caſe deſcended from the lock into the lower part of the canal; ſo that, in both

caſes,

cafes, the fame quantity of water is faved, that is, five-fixths of what would be neceffary were there no ciſterns. Suppofe again that, upon the fame canal, and immediately after the twelve feet lock, it would be advantageous to conftruct one of eighteen feet; then, in order not to ufe any greater quantity of water, it will be neceffary to have fixteen cifterns, upon different levels, communicating with the lock in the fame manner. Should again a lock of only fix feet be wanted, after that of eighteen, then it will only be neceffary to have four cifterns on different levels, (fee Fig. 1., Plate XVII.) and fo of any other height of lock. The rule is this: for finding the number and fize of the cifterns, each ciftern being the fame in fuperficies with the lock, its depth muft be fuch as to contain one half the quantity of water meant to be ufed in the paffing of one boat. The depth of the lock, divided by the depth neceffary for fuch a ciftern, will give, in all cafes, the whole number of cifterns, and two more; deduct the number two, therefore, from the number which you find by dividing the depth of the lock by the depth of one ciftern, and you have always

the

the number of cifterns required; which are to be placed upon different levels, according to the rule already given. The above is the principle, and manner of ufing the lock, for faving water in canals, and for enabling engineers to conftruct locks of different depths upon the fame canal, without ufing more water for the deep locks than for the fhallow ones. With regard to the manner of difpofing the cifterns, the circumftances of the ground, the declivity, &c. will be the beft guide for the engineer. I have, however, joined plans of two different methods of difpofing them; Fig. 1. is a lock where there are only four refervoirs wanted; Fig. 2. is one where there are ten wanted; and Fig. 3. is the fection of a lock twenty-four feet deep, where, in order to prevent too great a ftrain, from the weight of water upon the lower fluice, an arch of ftone or brick may be thrown over the lower part of the canal, under which arch the boats may pafs, and againft which the flood-gates of the lock will reft fupported. In putting this method in practice, to fave expence, as there can never be any great preffure of water in any of the cifterns, I propofe

to make the bottom of clay, and to ſurround them with brick or hewn ſtone. As to the lock itſelf, it is conſtructed in the uſual manner, except for the communications with the ciſterns; and, as it is neceſſary to avoid any accidents, from theſe communications being left open when they ought not ſo to be, there may be two valves upon each; the one to ſhut when preſſed upon by the water in the lock, and the other to ſhut when preſſed upon by the water in the ciſtern, which will be the caſe alternately, as the water is higher in the one or in the other; ſo that there will never be any communication, except when the valves are opened intentionally to let the water paſs. In Fig. 1. the ſection ſhews the levels of the different ciſterns, according to the principle laid down; and the plan ſhews only the manner of diſpoſing them, one by the ſide of the other, with one end towards the lock, which poſition is in general the moſt convenient. Fig. 2. ſhews the lock with ten ciſterns: it is to be obſerved that, as theſe ciſterns may be covered, the horſe-road will not be interrupted by them, though

they

they are on both ſides of the canal. In order to have as nearly equal preſſure as poſſible on both ſides of the lock, I have put the two ciſterns that are neareſt upon a level on the oppoſite ſides of the lock, ſo that No. 1 and 2, in place of being beſide each other, are ſeparated by the canal itſelf; though that precaution is not by any means neceſſary. Fig. 3. is only made to ſhew the way of throwing an arch over the lower part of the canal, to ſuſtain the weight of water, which would otherwiſe be too great for the ſluices or flood-gates. In witneſs whereof, &c.

Fig. 1. Plan

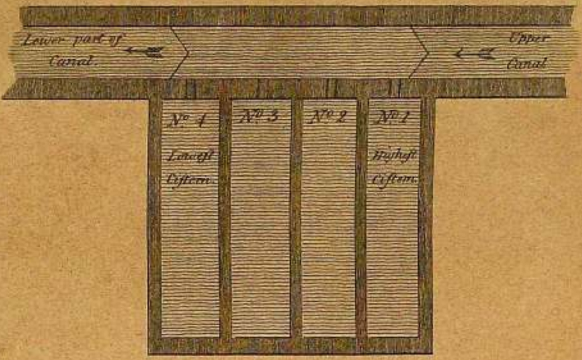


Fig. 1. Section

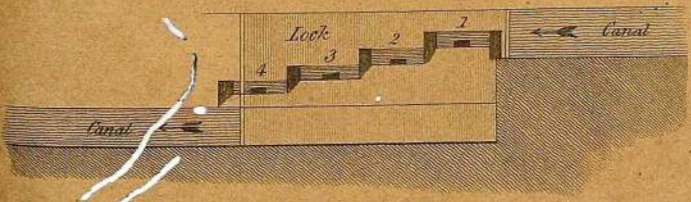


Fig. 2.

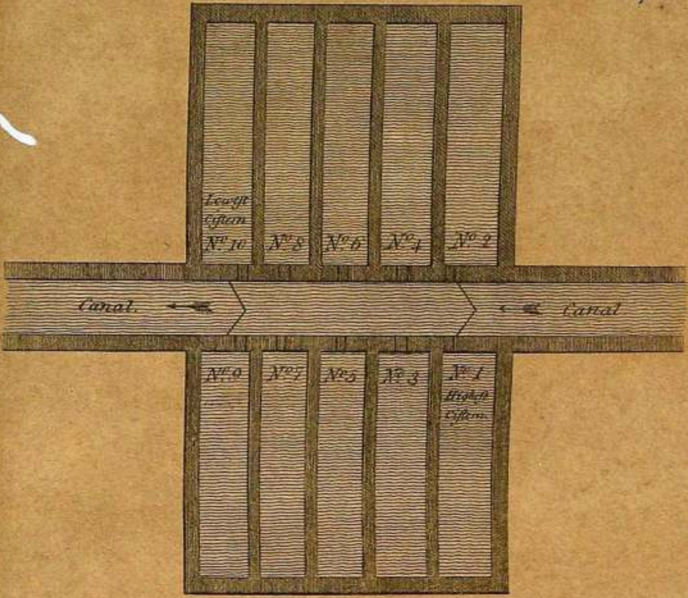
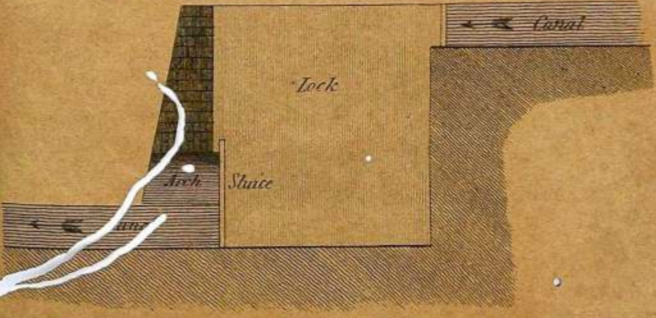

Lowest Cistern
No. 10
No. 8
No. 6
No. 4
No. 2
Canal.
Canal.
No. 9
No. 7
No. 5
No. 3
No. 1
Highest Cistern

Fig. 3.


Canal
Lock
Arch
Sluice

XL. *Specification of the Patent granted to Mr.* William Watts, *of the City of Briſtol, Plumber and Shot-Maker; for his Invention of making ſmall Shot ſolid throughout, without the Imperfections which other Shot uſually have on their Surface.*

Dated December 10, 1782.

TO all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid William Watts do hereby declare, that my ſaid invention of making ſmall ſhot ſolid throughout, perfectly globular in form, and without the dimples, ſcratches, and imperfections, which other ſhot, heretofore manufactured, uſually have on their ſurface, is performed in the manner following; that is to ſay, take twenty hundred weight of ſoft pig-lead, (more or leſs, according to the ſlag, or poiſoned lead, intended to be made,) melt it in an iron pot; then take about a peck of coal-aſhes, or dirt, ſtrew the

the ſame round the edge of the pot, upon the ſurface of the metal, leaving the middle of the metal naked; put in upon the metal which is uncovered with the aſhes, or dirt, about forty pounds weight of white or yellow arſenic: then cover the pot with an iron cover, and cloſe the edges of the cover, all round the pot, with mortar, clay, or dirt, to prevent the arſenic from evaporating; keep a good fire under the pot for three or four hours, ſo as to have the lead red-hot, that the arſenic may be mixed with the lead, and the lead thereby be fully poiſoned; then take off the cover, and ſkim the metal; then lade it off into moulds or ſand, to cool in bars or ingots, and which when cool is called ſlag, or poiſoned lead. Then take another twenty hundred-weight of ſoft pig-lead, (according to the quantity of ſhot intended to be made,) melt the ſame in an iron pot; then take about three-quarters of an hundred-weight of ſcum from clean pig-lead, put it into the pot, and let the ſame melt; when melted put in one of the bars or ingots of ſlag, or poiſoned lead; and, when melted, with a ſmall ladle take ſome of the metal out of the pot, and drop it in water from the

heigh-

height of about two feet; if the shot be not round, put in more of the slag or poisoned lead, till you find it drops round; then skim the metal, and put the scum into an iron or copper frame, full of holes, according to the size of the shot intended to be made; squeeze the scum, while soft in the frame, with the ladle with which it was taken out of the pot; then take the metal out of the pot, and pour it into the frame, over the surface of the scum, and let it drop through the frame into water. If for the smallest shot, the frame must be at least ten feet above the water, and for the largest shot about one hundred and fifty feet, or more, above the water, and so in proportion, according to the size of the shot intended to be made. In witness whereof, &c.

XLI. *Specification of the Patent granted to Mr.* HUMPHREY JACKSON, *of Great Tower-Hill, London; for his Method of beautifying, and preſerving the Colour of all Sorts of Wood, by Means of a Stain, Varniſh, and Powder; which Powder will likewiſe be uſeful in poliſhing and ſharpening Steel edged Inſtruments.*

Dated March 30, 1778.—Term expired.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Humphrey Jackſon do hereby declare, that my ſaid invention of an intire new method of beautifying and preſerving the native colour of all ſorts of wood, particularly mahogany, or furniture made thereof, in a very ſuperior manner to any hitherto practiſed, by means of a ſtain, varniſh, and powder, (which powder will alſo be extremely uſeful in poliſhing

and

and ſharpening all fine ſteel edged inſtruments,) is deſcribed in the manner following; that is to ſay, take pumice-ſtone, and burnt alum, of each equal parts, finely powdered, true lapis calaminaris, tile, and green vitriol calcined to redneſs, of each half a part, finely powdered, mix them into a powder, and rub the wood with it, with a woollen cloth, until it receive a good poliſh. (N. B. They muſt be finely levigated for edge-tools.) Then uſe the following ſtain: take ſix pounds of ſtick lac, boil it in three gallons of water till the colour is extracted, and ſtrain off the liquor; then add to it half a pound of madder-root, boil it till it is reduced to three quarts: take half a pound of cochineal, half a pound of kermes berries, and four ounces of clean ſcarlet rags, digeſt them in a glaſs veſſel with one gallon of ſpirit of wine, and two ounces of pearl-aſh diſſolved in half a pint of water, till all the colour is extracted; ſtrain, and add the decoction of ſtick lac to it; laſtly, add as much aquafortis as will bring it to a proper red colour, with which bruſh over the wood till it becomes of a proper colour.

The

The varnish.—Take a pound of clear white amber, and half a pound of gum copal, put them into a close vessel, with six pounds of oil of nuts, half a pound of spirit of turpentine, of oil of rosemary, and lavender, each half a pound; digest them in a sand-heat till the oils become as thick as syrup; strain for use; when clear, varnish the wood with a brush, and let it dry. In witness whereof, &c.

XLII. *Description of a Method of vein-marbling, and staining, Silk, Linen, Cotton, Paper, &c. In a Letter to the Editors, from Mr.* Samuel Toplis, *of Gainsborough.*

MAKE a middling thick size, or paste, of flour * and water, to which add a little powdered alum, and then boil it in the manner of glover's, &c. paste. Put some of the size, when cool, into several pots; and mix with it such kind of colours, or other matters used in staining and dying, as are had in esteem. Have ready a painter's brush to each pot, and, with any of the

* In case of scarcity and dearness of wheat-flour, (as at present,) any other light earthy substance may be used as a substitute, provided it possesses an attractive quality; that being absolutely necessary for the separation of the composition into veins, as above stated.

brushes,

brushes, spread a quantity of the forementioned coloured size, very even, on a flat piece of marble, or other kind of smooth stone, or on a smooth board, or on a table, according to the length and width of the piece of silk, linen, cotton, or sheet of paper. On the coloured size, thus spread, lay a strong plate of glass, or one of tin, or copper, or a thin piece of board, pressing the plate (of whatever sort) gently with the hand on every part. Raise the plate, by lifting up one end; and it will be found veined, in every direction, by the adhesiveness of the size: immediately lay the plate, thus prepared, on the silk, linen, or other article, and with the hand again gently press on every part of the plate, which will vein or marble the silk, linen, &c. with the same figures as were on the sized plate. If the plate of glass (which is preferable, but exceptionable on account of its brittleness) be not pressed too hard, a second impression, with a beautiful sort of smaller-sized veins, may be had from the first colouring; and, if two different colours are desired on the same surface, there needs only a repetition of the pro-

cefs with the fize,containing ftaining ingredients, and the other favorite colouring fubftances. I may add, that a neat fort of tortoifefhell appearance, and a great variety of expreffive figures, may be produced this way, as alfo by various actions of the fingers upon the plate, before the fize lofes its moifture, and likewife by many times folding the filk, linen, or other material of flexible texture.

I am, &c.

SAMUEL TOPLIS.

XLIII. *Deſcription of a Method of ſweeping narrow Chimneys, without the inhuman Practice of employing Children. In a Letter to the Editors.*

ON the cover of Number XV. of the Repertory ſeveral queſtions were propoſed, and among others, how to ſweep narrow chimneys, without the inhuman practice of employing children. This practice is the more inexcuſable, as in many large cities (Edinburgh, Glaſgow, &c.) a mode has been in uſe, time immemorial, which effectually anſwers the end intended: it is extremely ſimple, and any perſon may execute it from the following ſhort directions.

Procure a rope for the purpoſe, twice the length of the height of the chimney; to the middle of it tie a buſh (broom, furze, or any other,) of ſufficient ſize to fill the chimney; put one end of the rope down the chimney, (if there be any windings in it, tie a bullet or round ſtone to the end

end of the rope,) and introduce the wood end of the buſh after the rope has deſcended into the chamber; there let a perſon pull it down. The buſh, by the elaſticity of its twigs, bruſhes the ſides of the chimney as it deſcends, and carries the ſoot with it. If neceſſary, the perſon at top, who has hold of the other end of the rope, draws the buſh up again; but, in this caſe, the perſon below muſt turn the buſh, to ſend the wood end foremoſt, before he call to the perſon at top to pull it up.

Many people who are ſilent to the calls of humanity are yet attentive to the voice of intereſt: chimneys cleaned in this way never need a tenth part of the repairs required where they are ſwept by children; who, being obliged to work themſelves up by preſſing with their feet and knees on one ſide, and their back on the other, often force out the bricks which divide the chimneys. This is one of the cauſes why, in many houſes in London, a fire in one apartment always fills the adjoining ones with ſmoke, and ſometimes even the neighbouring houſe. Nay, ſome houſes have even been burnt by this means; for,

 a foul

a foul chimney, taking fire, has been frequently known to communicate, by theſe apertures, to empty apartments, or to apartments filled with lumber, where, of courſe, it was not thought neceſſary to make any examination, after extinguiſhing the fire in the chimney where it began.

Some time ago an Act of Parliament was paſſed, enacting that all children employed in ſweeping chimneys ſhould have braſs plates on the front of their caps, with their maſters' names engraved upon them, that, when any of the boys were ill uſed, their maſters might be known and puniſhed. An act to prevent altogether the inhuman practice would be productive of much more ſolid advantages. It would be no injury to thoſe who at preſent live by that employment; for chimney-ſweepers would then be as neceſſary for the convenience of the public as now; and thoſe who are now employed are the very people who would then provide themſelves with ropes and buſhes, or with bruſhes made for the purpoſe.

I. T.

XLIV. *Conclusion of Mr.* KEIR's *Experiments and Observations on the Dissolution of Metals in Acids, and their Precipitations, &c.*

(FROM p. 275.)

5. TO another portion of the saturated solution of silver, I added some red smoking nitrous acid; and I found, upon trial, that iron precipitated the silver from this mixture, and that the same appearances were exhibited as had been observed with the solution previous to its saturation.

6. The same effects were produced when vitriolic acid was added to the saturated solution of silver, and iron afterwards applied.

7. To some of the same nitrous acid, of which a part had been employed to dissolve the silver, I added a piece of iron; and, while the iron was dissolving, I poured into the liquor some of the saturated

ſaturated ſolution of ſilver; upon which a precipitation of ſilver took place inſtantly; although, when the ſame acid had been previouſly mixed with the ſolution of ſilver, and the iron was then added to the mixture, no precipitation had enſued.

8. The quantity of vitriolic acid, or of the red fuming nitrous acid, neceſſary to communicate to the ſaturated ſolution of ſilver the property of being acted on by iron, varies according to the concentration, and to the degree of phlogiſtication, of the acids added; ſo that a leſs quantity than is ſufficient does not produce any apparent effect. Nevertheleſs, when the ſolution of ſilver is, by addition of theſe acids, brought nearly to a precipitable ſtate, the addition of ſpirit of wine will, in a little time, render it capable of acting on iron.

9. It appears then, that a ſolution of ſilver is not precipitated by iron in cold, unleſs it have a ſuperabundance of phlogiſticated acid *.

10. Heat

* It was ſaid at § 4, that the addition of dephlogiſticated nitrous acid to a ſaturated ſolution of ſilver did not render this

10. Heat affects the action of a folution of filver on iron; for, if iron be digefted with heat, in a perfectly faturated folution of filver, fuch as a folution of cryftals of nitre of filver in water, the filver will be depofited in its bright metallic ftate on different parts of the iron, and the iron which has been acted on by the folution appears in form of a yellow ochre.

11. Bergman relates, that he has fometimes obferved beautiful cryftallizations or vegetations

this folution precipitable by iron. Neverthelefs, as this acid diffolves iron, fuch a quantity may be added as to overcome the counteracting quality of the folution of filver, fo that the acid fhall be able to act on the iron; and, while this metal is diffolving, it phlogifticates the mixture, which then becomes capable of being precipitated, and is in fact reduced to the fame circumftances as are defcribed at § 7. The limits of the quantities which produce changes cannot be afcertained, becaufe they depend on the degrees of concentration and phlogiftication of the fubftances employed; and therefore, whenever a change is faid to be produced by a certain fubftance, it means that it may be produced by *fome* proportion, but does not imply by *every* proportion, of that fubftance. Without attending to thefe confiderations, perfons trying to repeat the experiments mentioned in this paper will be liable to be deceived.

of

of metallic filver, formed on pieces of iron immerfed long in a folution of filver.

I have found that no time is able to effect this depofition, unlefs the folution be in a ftate *nearly* fufficiently phlogifticated to admit of a precipitation by iron, but not completely phlogifticated enough to effect that purpofe immediately.

12. Dilution with a great deal of water feemed to difpofe the folutions of filver to be precipitated by iron more eafily. A folution of filver which did not act on iron, upon being very much diluted, and having a piece of iron immerfed in it during feveral hours, gave a precipitate of filver in the form of a black powder.

Section II.

On the Alterations which Iron, or its Surface, undergoes by the Action of a Solution of Silver in nitrous Acid, or of a pure concentrated nitrous Acid.

13. It has been faid, that when iron is expofed to the action of a phlogifticated folution of filver, it

it inftantly precipitates the filver, is itfelf acted upon or diffolved by the acid folution, during a certain time, (longer or fhorter, according to the degree of phlogiftication, quantity of fuperabundant acid, and other circumftances,) and that at length the folution of the iron ceafes; the filver precipitate is re-diffolved, if there is fuperfluous acid; the liquor becomes clear again, but only rendered a little browner by its having diffolved fome iron; while the piece of iron remains bright and undifturbed at the bottom of the liquor, where it is no longer able to affect the folution of filver.

14. I poured a part of the phlogifticated folution of filver, which had paffed through thefe changes, and which had ceafed to act upon the piece of iron, into another glafs, and dropped another piece of frefh iron wire into the liquor; upon which I obferved a precipitation of filver, a folution of part of the iron, a re-diffolution of the precipitated filver, and a ceffation of all thefe phænomena, with the iron remaining bright and quiet at the bottom of the liquor, as before. It

appeared then, that the liquor had not lost its power of acting on *fresh* iron, although it ceased to act on that piece which had been exposed to it.

15. To one of the pieces of iron which had been employed in the precipitation of a solution of silver, and from which the solution, no longer capable of acting upon it, had been poured off, I added some phlogisticated solution of silver, which had never been exposed to the action of iron, but no precipitation happened. It appeared then, that the iron itself, by having been once employed to precipitate a solution of silver, was rendered incapable of any farther action on any solution of silver; and it is to be observed, that this alteration was produced without the least diminution of its metallic splendor, or change of colour. The alteration, however, was only superficial, as may be supposed; for, by scraping off its altered coat, it was again rendered capable of acting on a solution of silver. To avoid circumlocution, I shall call iron, thus affected, *altered* iron; and iron which is clean, and has not been altered, *fresh* iron.

16. To

16. To a phlogisticated solution of silver, in which a piece of bright altered iron lay, without action, I added a piece of fresh iron, which was instantly enveloped with a mass of precipitated silver, and acted on as usual; but, what is very remarkable, in about a quarter of a minute, or less, the altered iron suddenly was covered with another coat of precipitated silver, and was now acted on by the acid solution, like the fresh piece. In a little time the silver precipitate was re-dissolved, as usual, and the two pieces of iron were reduced to an altered state. When a fresh piece of iron was then held in the liquor, so as not to touch the two pieces of altered iron, they were nevertheless soon acted upon by the acid solution, and suddenly covered with silver precipitate, as before; and these phænomena may be repeated, with the same solution of silver, until the superfluous acid of the solution becomes saturated by the iron, and then the re-dissolution of the precipitated silver must cease.

17. I poured some dephlogisticated nitrous acid on a piece of altered iron, without any action

 ensuing,

enſuing, although this acid readily acted on freſh iron; and when, to the dephlogiſticated nitrous acid, with a piece of altered iron lying immerſed in it, I added a piece of freſh iron, this immediately began to diſſolve, and ſoon afterwards the altered iron was acted on alſo by the acid.

28. I poured upon a piece of altered iron a ſolution of copper in nitrous acid; but the copper was not precipitated by the iron; neither did this iron precipitate copper from a ſolution of blue vitriol.

19. Altered iron was acted on by a dilute phlogiſticated nitrous acid; but not by a red concentrated acid, which is known to be highly phlogiſticated.

20. I put ſome pieces of clean freſh iron wire into a concentrated and red fuming nitrous acid. No apparent action enſued; but the iron was found to be altered in the ſame manner as it is by a ſolution of ſilver; that is, it was rendered incapable of being attacked, either by a phlogiſticated ſolution of ſilver, or by dephlogiſticated nitrous acid.

21. Iron was alſo altered by being immerſed ſome little time in a ſaturated ſolution of ſilver, which did not ſhew any viſible action on it.

22. The alteration thus produced on the iron is very ſuperficial: the leaſt rubbing expoſes ſome of the freſh iron beneath the ſurface, and thus ſubjects it to the action of the acid.

It is therefore with difficulty that theſe pieces of altered iron can be dried, without loſing their peculiar property. For this reaſon, I generally transferred them out of the ſolution of ſilver, or concentrated nitrous acid, into any other liquor, the effects of which I wanted to examine. Or they may be transferred firſt into a glaſs of water, and thence into the liquor to be examined; but it is to be obſerved, that if they are allowed to remain long in the water, they loſe their peculiar property or alteration. They may be preſerved in their altered ſtate by being kept in ſpirit of ſal ammoniac.

23. To a ſaturated ſolution of copper in nitrous acid, (which was capable of being readily precipitated by freſh iron,) I added ſome ſaturated ſolu-

tion

tion of silver. From this mixture a piece of fresh iron neither precipitated silver nor copper; nor did the addition of some dephlogisticated nitrous acid effect this precipitation.

24. A solution of copper, formed by precipitating silver from nitrous acid by means of copper, was very reluctantly and slowly precipitated by a piece of fresh iron; and the iron thus acted on by the acid was changed to an ochre.

25. A saturated solution of silver, having been *partly* precipitated by copper, acquired the property of acting upon fresh iron, and of being thereby precipitated.

26. Fresh iron, immersed some time in solutions of nitre of lead, or of nitre of mercury, in water, did not occasion any precipitation of the dissolved metals; but acquired an *altered* quality. These metals then in this respect resemble silver.

27. It is well known, that a solution of martial vitriol, added to a solution of gold in aqua regis, precipitates the gold in its metallic state. I do not recollect that the precipitation of a solution of silver, by the same martial vitriol, has been observed.

obferved. However, upon pouring a folution of martial vitriol into a folution of filver in the nitrous acid, a precipitate will be thrown down, which acquires in a few minutes more and more of a metallic appearance, and is indeed perfect filver. When the two folutions are pretty much concentrated, a bright argentine film fwims on the furface of the mixture, or filvers the fides of the glafs in which the experiment is made. When a phlogifticated folution of filver is ufed, the mixture is blackened, as happens generally to a folution of martial vitriol, when a phlogifticated nitrous acid is added to it.

I added about equal parts of water to a mixture of a phlogifticated folution of filver and a folution of martial vitriol, in which *all* the filver had been precipitated, and digefted the diluted mixture with heat, by which means moft of the precipitated filver was re-diffolved. Bergman has obferved a fimilar re-diffolution of gold precipitated by martial vitriol, upon boiling the mixture; but he attributes the re-diffolution to the concentration of the aqua regis by the evaporation.

As this explanation did not accord with my notion, I diluted the mixture with water, and found that the fame re-diffolution occurred, both with the folution of filver and with that of gold; but with neither of the metals did I find that the re-diffolution ever took place, unlefs there had been a fuperabundant acid in the folutions of gold and filver employed.

28. Mercury is alfo precipitated in its metallic ftate, from its folution in nitrous acid, by a folution of martial vitriol. When the liquor is poured off from the precipitate, this may be changed into running mercury, by being dried near the fire.

29. I found alfo, that filver may be precipitated in its metallic ftate, from its folution in vitriolic acid, by addition of a folution of martial vitriol. A vitriol of mercury may alfo be decompounded by a folution of martial vitriol; and the mercurial precipitate, which is a black powder, forms globules, when dried and warmed.

30. Luna cornea is not decompounded by martial vitriol, confequently there is no operation of a double affinity. Neverthelefs, this luna cornea

may

may be decompounded by the elements of martial vitriol, while they are in the act of dissolution; that is, the silver may be precipitated in its metallic state, by digesting luna cornea with a dilute vitriolic acid, to which some pieces of iron are added. And it is to be observed, that this reduction of the silver and precipitation take place while the acid is yet unsaturated. Marine acid and iron, applied to luna cornea, effect the same reduction of the silver to a metallic state, even when there is more acid than is sufficient for both metals.

XLV. *Deſcription of a Mercurial Level; invented by* Alexander Keith, *Eſq. F. R. S. and A. S. Edinb.*

WITH A PLATE.

From the Transactions of the Royal Society of Edinburgh.

FIGURE 1. (Plate XIX.) is a ſection of the inſtrument, formed of mahogany, or box-wood. A A are two oblong ſquare cavities, connected together by a narrow cloſe channel, running from the bottom of the one to the other. B B are two grooves, hollowed out of the wood, in order to contain the ſights, &c. when not in uſe; they are ſhut up by a lid, which turns upon a ſcrew-nail at the centre C, as may be ſeen more diſtinctly from Fig. 4.

Fig. 2. D D are two ſights, the one with a ſmall hole, the other with a croſs hair. Theſe ſights are erected upon two pieces of ivory, or hard wood, which are ſhaped nearly of the dimen-

ſions of the cavities A A, but ſo much ſmaller as to enter without touching or rubbing on the ſides. Mercury is poured into the two cavities A A, till they are about half full; the two pieces of ivory, or hard wood, which ſupports the ſights, are then put into the cavities, and float upon the ſurface of the mercury.

Fig. 3. is a perſpective view of the inſtrument, when the ſights are floating upon the mercury.

Fig. 4. is another view of it, when the ſights are taken out, and the lid is open.

As the two cavities communicate with each other, the ſurface of the mercury, in both, is always upon the ſame line of level; and conſequently, if the two ſights are once accurately adjuſted, they will ever after point out the true level, without requiring any after-adjuſtment.

When this inſtrument is to be uſed, it may be laid on any horizontal ſurface, and the ſights will immediately become an exact level. It may alſo be fixed on a tripod, like the ſpirit-level; or, it will anſwer equally well if it is affixed to the top of a ſingle ſtake, which is ſharpened at the point, ſo as to be puſhed into the ground. If it is to be

 uſed

ufed as a pocket-inftrument, it may be made feven inches in length; being about double the dimenfions of the annexed draught. In that cafe, a common walking-ftick forms a very convenient fupport: it is affixed to the ftick by means of a brafs pin E, (Fig. 2.) which paffes through the hole G, (Figs. 3 and 4.) and through the eye, or hole, of the walking-ftick; a brafs nut F, (Fig. 2.) fcrewing on the male-fcrew of the brafs pin E, keeps them firm together.

The two grooves B B contain the two fights, and brafs pin, when not in ufe. Two corks, covered with thin leather, fitted into the cavities A A, confine the mercury when the inftrument is to be tranfported; or, in cafe the mercury is found to efcape, it may be poured into a fmall cafe, made of lignum vitæ, like a tooth-pick cafe, which may be ftopped with a cork, and made to fit into one of the grooves.

The advantages of this inftrument over the fpirit-level are:

Firft. It requires no adjuftment, confequently two obfervers, though otherwife not equally accurate, muft make the fame obfervation.

 Secondly.

Secondly. With this, the level of twenty different places may be taken, during the time required to adjuſt the ſpirit-level for one obſervation.

Thirdly. The nicety of the ſpirit-level depends upon the ſmall curve of the glaſs tube, in the choice of which no rule can be laid down; neither is any thing gained, in point of exactneſs, by lengthening the ſpirit-tube above three or four inches. But every inſtrument of this kind is of one ſtandard; and, the farther the two ſights are removed from each other, the more any error is diminiſhed.

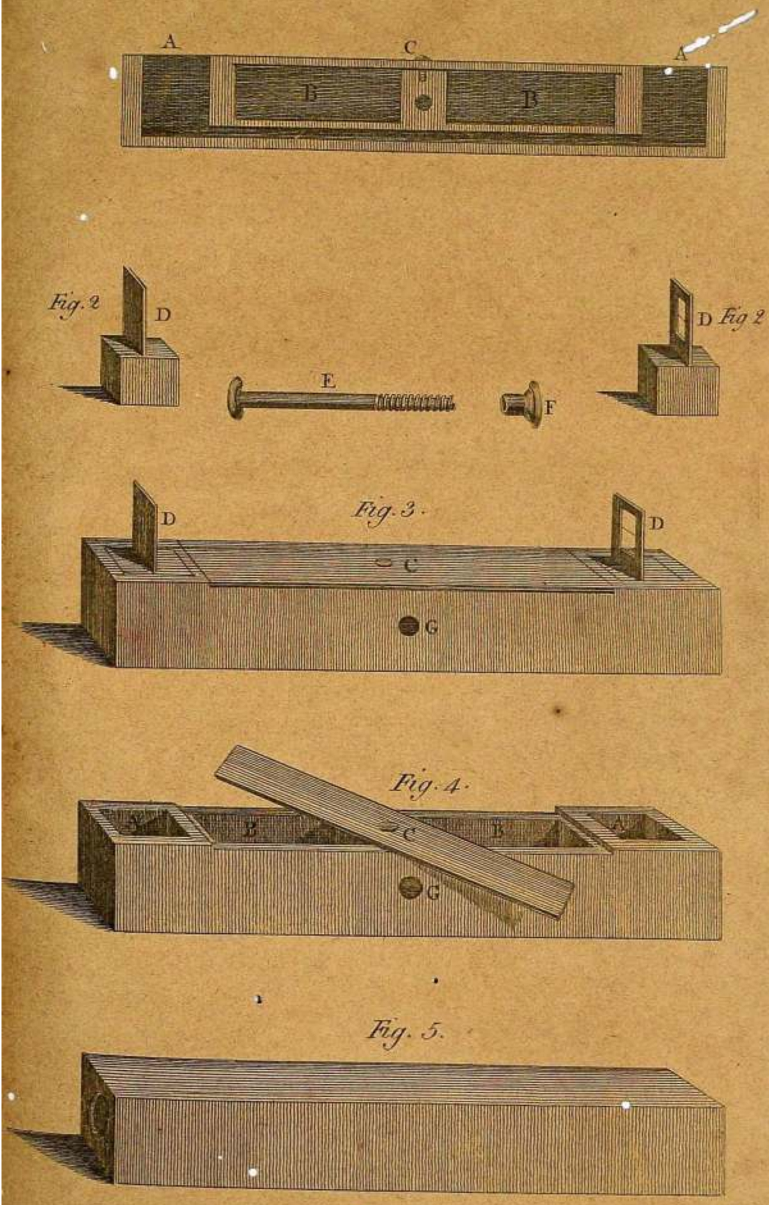
Fourthly. This inſtrument can be made perfectly juſt, without taking any obſervation, or comparing it with another level. In order to do this, let the floats on which the ſights reſt be of the ſame dimenſion and weight, and let the croſs hair and eye-hole be one height, and, without farther adjuſtment, they will point out the true level.

The following is a proof of the exactneſs of this method. John Miller, mathematical-inſtrument-

ment-maker, has a line drawn on the oppofite fide of the Parliament-fquare, fronting his fhop, by which he has been ufed to adjuft his fpirit-levels. We placed the mercurial level upon the fpot known to be upon an exact level with the line: both he and I looked through the fights, but could not perceive the line; we fufpected there was fome fault in the fights, but, on making them vibrate, we found that the hair had covered the line; as foon as they fettled, the line was again covered by the hair.

When there is a ftrong wind, the fights vibrate too much: in order to remedy this, there is a cafe of tinned plate, or pafteboard, made to inclofe the inftrument, when not in ufe. (See Fig. 5.) When ufed, the cafe covers only about one half of it, leaving room for the fights to float within the cafe. There are two oval holes, one at each end of the cafe, through which the obfervations are made.

XLVI.


A
C
A
B
B
Fig. 2
D
D Fig 2
E
F
Fig. 3.
D
D
C
G
Fig. 4.
A
B
C
B
A
G
Fig. 5.

XLVI. *Deſcription of a Pentrough, for equalizing the Water falling on Water-Wheels; by* George Quayle, *Eſq.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The Silver Medal of the Society was voted to Mr. Quayle for this Invention.

In all mills, worked by water, ſome inconvenience is found to ariſe from the irregularity of ſpeed, occaſioned by the variation of the head of water at the Pentrough. The ſpecific weight being neceſſarily proportioned to the perpendicular altitude of the water, its velocity is increaſed by a greater, and diminiſhed by a leſs head. No accurate judgement, as to the quantity of water really

really admitted, can be formed from the pofition of the fhuttle: the fpace only is regulated by this; but the quantity of water paffing through that fpace depends on its fpecific gravity, in proportion to which its courfe is accelerated. Befides, where the race is of any confiderable length, the rain-water which falls into it, and that which gains admiffion from the adjoining lands, baffles all calculation, as to the quantity really paffing into the dam or refervoir; and the fhuttles at the dam-head are fubject to the fame evil. Any irregularity, in the head of water falling on the wheel, is of courfe communicated to the internal machinery; from which much inconvenience muft arife, in all manufactories where precifion in the movements is requifite, and particularly in thofe of filk, and cotton.

The giving an even regular motion to water-wheels appears therefore a *defideratum* in hydraulics. It can only, I conceive, be obtained by equalizing the quantity of water falling on the wheel; but, whilft the ufual fyftem is purfued, of delivering it from the bottom of the pentrough, it does not

appear

appear eaſy to ſuggeſt means by which all irregularity can be prevented.

In order to remedy this inconvenience, and inſure a conſtantly regular ſupply of water on the wheel, it appeared to me, that means might be deviſed of regulating the quantity delivered, by a float, and taking the whole of the water from the ſurface.

After ſeveral experiments, the machine of which I have now the honour of ſending a ſketch and deſcription, and of which a model accompanies this, bids fair to anſwer the purpoſe.

Another advantage attends the uſe of this ſhuttle: room may be ſaved in the extent of the dam, as the water may be ſuffered to riſe to a greater height, without the inconvenience attending the increaſed velocity of its diſcharge. In caſes alſo of temporary deficiency, the water which remains will, by this means, be worked to the greateſt advantage.

Description of the Figures.

Fig. 1.

Section of the Pentrough.

A. The entrance of the water.

B. The float, having a circular aperture in the centre, in which is ſuſpended

C. A cylinder, running down, in the caſe E, below the bottom of the pentrough. This is made water-tight, at the bottom of the pentrough, at F, by a leather collar, placed between two plates, and ſcrewed down to the bottom.

The cylinder is ſecured to the float, ſo as to follow its riſe and fall; and the water is admitted into it through the opening in its ſides; and there, paſſing through the box or caſe E, riſes and iſſues at G, on the wheel. By this means, an uniform quantity of water is obtained at G; which quantity can be increaſed or diminiſhed, by the aſſiſtance of a ſmall rack and pinion, attached to the cylinder, which will raiſe or depreſs the cylinder, above or under the water-line of the float; by

by raiſing it up to the top, it ſtops the water intirely, and anſwers the purpoſe of the common ſhuttle. This pinion is turned by the handle H, ſimilar to a winch-handle; and is ſecured from running down, by a ratchet-wheel at the oppoſite end of the pinion axis.

K and L. Are two upright rods, to prevent the perpendicular riſe and ſinking of the float, running through the float, and being ſecured at the top, by brackets from the ſides.

M. Is a board let down acroſs the pentrough, nearly to the bottom, to prevent the horizontal impulſe of the water from diſturbing the float.

Fig. 2.

A croſs ſection, ſhewing the mode of fixing the rack and pinion, and their ſupporters, on the float. The rack is inſerted into a piece of metal running acroſs the cylinder, near the top.

That the water may paſs more freely, when nearly exhauſted, the bottom of the cylinder is

 not

not a plane, but is cut away ſo as to leave two feet, as at C, Fig. 1.

The float is alſo kept from lying on the pen-trough bottom, by four ſmall feet; ſo that the water gets under it regularly from the firſt.

Fig. 3.

An enlarged view of the cylinder, ſhewing the rack and ratchet-wheel, with the click, and one of the openings on the ſide of the cylinder. The winch or handle being on the oppoſite ſide, and the pinion, by which the rack is raiſed, incloſed in a box between them.

The ſcale of the model is one inch to a foot.

The annexed figures are reduced to one-ſixth.

Fig. 1.

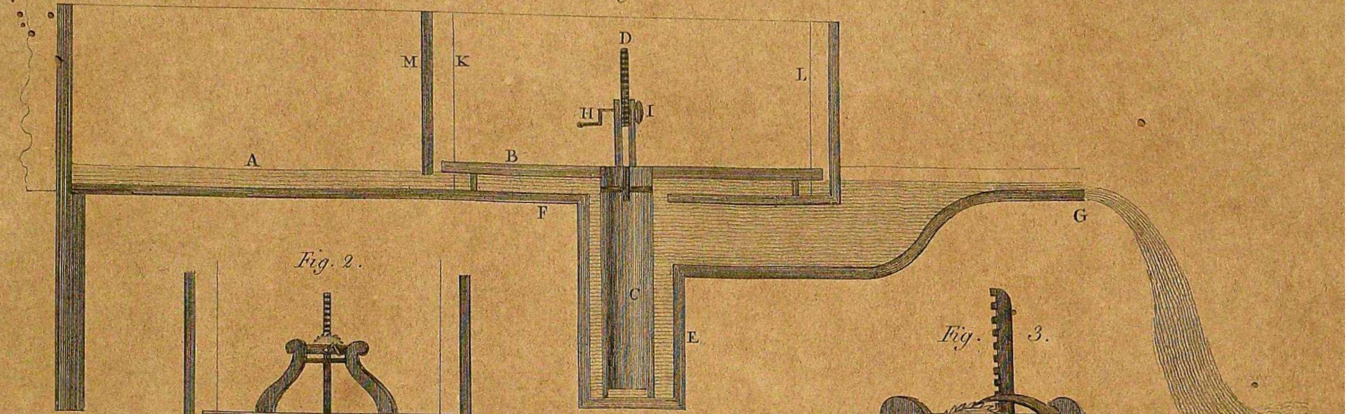


Fig. 2.

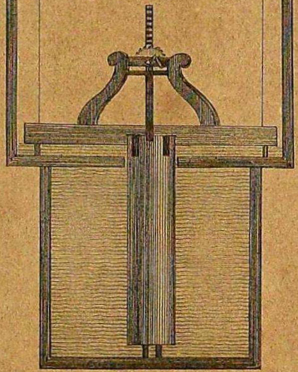
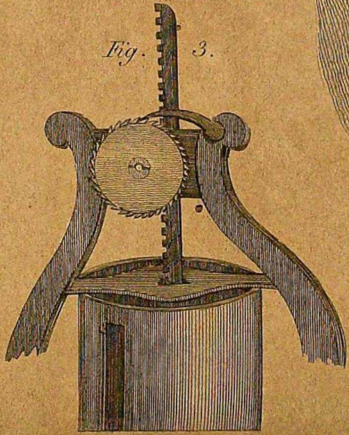


Fig. 3.



XLVII. *Method of preparing Naples Yellow; by* M. Couret.

FROM THE *JOURNAL DE PHYSIQUE.*

THE beautiful yellow colour commonly ſold under the name of Naples yellow is well known; thoſe who buy it are often impoſed upon by being told that it is a ſubſtance produced from Mount Veſuvius.

The firſt author who has ſpoken of it, as a compoſition by art, is M. Beckmann, who has taken his proceſs from a work written by the Abbé Paſſeri.

According to the latter it is compoſed of the following ſubſtances, viz. one pound of antimony, one pound and a half of lead, half an ounce of alum, and the ſame quantity of common ſalt. With reſpect to the proceſs, or mode of preparation, Paſſeri is ſilent. Probably the antimony and lead ſhould be calcined together, afterwards the other ingredients added, and then the whole mixture undergo a ſecond calcination, in the manner deſcribed.

Th

The ſecond author who ſpeaks of the compoſition of this colour is M. Fougeroux de Bondaroy; and, upon the whole, his proceſs agrees with the preceding.

To procure this colour we muſt take twelve ounces of white lead, three ounces of diaphoretic antimony, alum and ſal ammoniac of each one ounce. All theſe muſt be ground together dry upon a levigating ſtone: they muſt then be put into an open crucible, and expoſed to a gentle fire for ſome hours; the fire is afterwards to be increaſed during a certain time; and finally the mixture is to continue three hours in a degree of heat ſufficient to keep the crucible red-hot. The maſs will then be found to have acquired a beautiful yellow colour. If it is wiſhed to be more of the colour of gold, a greater quantity of diaphoretic antimony and ſal ammoniac muſt be added to the other ingredients.

It is probable that, inſtead of diaphoretic antimony, the grey calx of antimony might be made uſe of.

XLVIII.

XLVIII. *Obſervations on the Mechaniſm of Felting;* *by* M. Monge.

FROM THE *ANNALES DE CHIMIE.*

IF we examine, in a microſcope, human hair, wool, the hair of a rabbit, hare, beaver, &c. however great the magnifying power of the inſtrument may be, the ſurface of each hair appears perfectly ſmooth and even; or at leaſt, if any inequalities are to be perceived, they ſeem rather to ariſe from ſome difference in the colour and tranſparency of particular parts of theſe ſubſtances than from the irregularity of their ſurfaces; for, their image, when viewed by a ſolar microſcope, is terminated by even lines, without any roughneſs. The ſurface of theſe objects, however, is by no means ſmooth; on the contrary, it appears

to

to be formed either of *lamellæ* which cover each other from the root to the point, pretty much in the ſame manner as the ſcales of a fiſh cover the animal from the head to the tail; or, more probably, of zones placed one over the other, like what is obſerved in the ſtructure of horns: to this conformation it is, that the ſubſtances here treated of owe their diſpoſition to what is called *felting*.

If, with one hand, we take hold of a hair by the root, and draw it between two fingers of the other, from the root towards the point, we are hardly ſenſible of any friction or reſiſtance, nor can we diſtinguiſh any ſound; but if, on the contrary, we hold the hair at the point, and draw it between the fingers, from the point towards the root, we are ſenſible of a reſiſtance which did not exiſt in the former caſe; a ſort of tremulous motion is likewiſe produced, which is not only perceptible to the touch, but may alſo be diſtinguiſhed by the ear.

It is evident therefore, that the texture of the ſurface of a hair is not the ſame from the root towards the point as from the point towards the root;

root; and that a hair, when grafped, muft offer more refiftance in fliding or moving progreffively towards the point than towards the root. As this texture is the principal object of this memoir, I think it neceffary to demonftrate it by fome other obfervations.

If a hair, after being taken hold of by the fore finger and thumb, be rubbed by them, in the longitudinal direction of the hair, a progreffive motion takes place, and this motion is always towards the root. This effect does not at all depend on the nature of the fkin of the fingers, or its texture; for, if the hair be turned, fo that the point is placed where the root was, the movement then becomes contrary to what it was before; that is to fay, it is always directed towards the root.

What is obferved, in the above inftance, is entirely analogous to what happens when country children, by way of fport, introduce an ear of rye, or barley, between the wrift and the fhirt, the points of the beards of which are directed outwards. By the various motions of the arm, this

ear, ſometimes catching againſt the ſhirt, ſometimes againſt the ſkin, takes a progreſſive motion backwards, and ſoon gets up to the arm-pit. It is very clear that this effect is produced by the beards of the ear, and indeed chiefly by the aſpeṙities upon thoſe boards; which, being all directed towards the point, do not permit the ear to move in any other direction than towards that part to which it was united to the ſtalk. There is no doubt that it is the ſame with reſpect to hair; and that its ſurface is beſet with aſperities, which, being laid one upon the other, and turned towards the points, permit no motion but towards the root.

A tight knot, made in the middle of a hair, is very difficult to untie by the uſual means, on account of the extreme thinneſs of the hair; but if we place the hair in the bend of the hand, ſo that the knot is in a line with the little finger, and, after graſping the hair by cloſing the hand, we ſtrike the fiſt ſeveral times againſt the knee, the aſperities of one end of the hair being now in a contrary direction to thoſe of the other, each of the ends recedes a little, one of them

them one way, the other the contrary way; the knot is thereby opened, and, by introducing a pin into the eye which is formed, it is very eafy to finifh untying it.

Thefe obfervations, which it would be ufelefs to multiply, relate to long hair, that having been taken as an example; but they apply, with equal propriety, to wool, furs, and, in general, to every kind of animal hair. The furface of all thefe is therefore to be confidered as compofed of hard *lamellæ* placed one upon another, like tiles, from the root to the point; which *lamellæ* allow the progreffive motion of the hair towards the root, but prevent a fimilar motion towards the point.

From what has been faid, it is eafy to explain why the contact of woollen ftuffs is rough to the fkin, while that of linen or cotton cloths is fmooth; the reafon is, the afperities upon the furface of the fibres of the wool, (notwithftanding the flexibility of each particular fibre,) by fixing themfelves in the fkin, produce a difagreeable fenfation, at leaft till we are accuftomed to it; whereas, the furface of the fibres of hemp or flax, of which linen is made,

being perfectly ſmooth, do not cauſe any ſuch ſenſation. It is alſo evident that the injury ariſing to wounds or ſores, from the application of wool, does not proceed from any chemical property, but is occaſioned ſolely by the conformation of the ſurface of the fibres; the aſperities of which attach themſelves to the raw and expoſed fleſh, which they ſtimulate and irritate to ſuch a degree as to produce inflammation.

This conformation is the principal cauſe of that diſpoſition to what is called felting, which the hair of ail animals in general poſſeſſes.

The hatter, by ſtriking the wool with the ſtring of his bow, ſeparates the hairs from each other, and cauſes them to ſpring up in the air; the hairs fall again on the table, in all poſſible directions, ſo as to form a layer of a certain thickneſs, and the workman covers them with a cloth, which he preſſes with his hands, moving them backwards and forwards in various directions. This preſſure brings the hairs againſt each other, and multiplies their points of contact; the agitation of them gives to each hair a progreſſive motion towards the root;

by

by means of this motion, the hairs are twisted together, and the *lamellæ* of each hair, by fixing themselves to those of other hairs which happen to be directed the contrary way, keep the whole in that compact state which the pressure makes it acquire. In proportion as the mass becomes compact, the pressure of the hands should be increased; not only to make it more close, but also to keep up the progressive motion and twisting of the hairs, which then takes place with greater difficulty; but, throughout the whole of this operation, the hairs fix themselves only to each other, and not to the cloth with which they are covered, the fibres of which, as we have already said, are smooth, and have not that disposition to felting which we have described above.

It may not be amiss here to explain why that hair which is intended for making hats is always cut off with a sharp instrument, (although that cannot be done without losing a part of its length,) and not plucked out by the roots, as might be done after softening the skin; the reason is, the bulb of the hair, which, in the latter case, would

come out with it, would render that end which was fixed in the ſkin thick and obtuſe; and it would conſequently be leſs diſpoſed to introduce itſelf among the contiguous hairs, and to contribute by its progreſſive motion to the contexture of the maſs.

The above-deſcribed conformation of the ſurface of hairs and wool is not the only cauſe which produces their diſpoſition to felting. It is not ſufficient that every hair poſſeſſes the fore-mentioned tendency to move progreſſively towards the root, and that the inclined *lamellæ*, by hooking themſelves to each other, preſerve the maſs in that ſtate to which compreſſion has brought it; but it is alſo neceſſary that the hairs ſhould not be ſtraight, like needles; if they were ſo, preſſing and rubbing them together would merely cauſe them to continue their progreſſive motion, without changing their direction; and the effect of thoſe operations would only be to make them move from the centre of the maſs, without producing any compactneſs in it. Every hair muſt therefore be twiſted, or curled, in ſuch a manner that the

extremity which is towards the root may be dif-pofed to change its direction perpetually; to twift itfelf about other heirs; and to incline towards it-felf again, in cafe it fhould be determined thereto by any change in the pofition of the reft of its length. It is becaufe wool has naturally this crooked form that it is fo proper for felting; and that it may be made ufe of, for that purpofe, with-out undergoing any previous preparation.

But the hairs of the beaver, the rabbit, the hare, &c. being naturally ftraight, cannot be employed *alone* in felting, till they have under-gone a preliminary operation; which confifts in rubbing or combing them, before they are taken off the fkin, with a brufh dipped in a folution of mercury in *aqua fortis*; this liquor, acting only on one fide of the fubftance of the hairs, changes their direction from a right line, and gives them that difpofition to felting which wool naturally poffeffes.

When the hairs are not intended to enter into the body of the mafs, but are only to be em-ployed in making a fort of external coating, fuch

as is fometimes given to the outer furface of hats, the operation juft mentioned need not be performed; but, the felt on which they are to be fixed being finifhed, the hair is uniformly fpread upon the furface to which the coating is to be applied; and, being covered with a cloth, it is preffed with the hands, and agitated for a certain time. By thefe means, the hairs introduce themfelves, by the root, a certain depth into the felt, and are there fixed, by their *lamellæ*, in fuch a manner as not to be eafily extracted: a particular direction is afterwards given to them by means of a brufh, and they are made to keep this direction by having a hot iron paffed over them. If the agitation were continued for a longer time, thefe hairs, not having their ftraitnefs deftroyed by the operation before defcribed, would pafs entirely through the felt, going out at the oppofite furface, as each hair follows exactly the direction it acquired at the beginning.

TO BE CONCLUDED IN OUR NEXT.

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XVIII.

XLIX. *Specification of the Patent granted to* HENRY CORT, *of Funtly Iron Mills, in the Parish of Titchfield, in the County of Southampton, Esq. for a new Mode and Art of shingling, welding, and manufacturing, Iron and Steel into Bars, Plates, &c. of purer Quality, in large Quantities, by a more effectual Application of Fire and Machinery, and with greater Yield, than by any Method before attained, or put in Practice.*

Dated February 13, 1784.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Henry Cort, in con-

compliance with the ſaid letters patent, and in performance of a condition or proviſo therein contained for that purpoſe, have deſcribed and aſcertained, and by theſe letters patent do deſcribe and aſcertain, the nature of my ſaid invention, and the manner of performing the ſame, as followeth; that is to ſay, for the preparing, manufacturing, and working of iron from the ore, as well as from ſow and pig metal, and, alſo from every other ſort of caſt iron, together with or without ſcull and cinder iron, and wrought-iron ſcraps, I make uſe of a reverberatory or air furnace or furnaces, of dimenſions ſuited to the quantity of work required to be done, the bottoms of which are laid hollow, or diſhed out, ſo as to contain the metal when in a fluid ſtate. My furnace, for the firſt part of the proceſs, being got up to a proper degree of heat, by raw pit-coals, or other fuel, the fluid metal is conveyed into the air-furnace by means of ladles, or otherwiſe. When this air-furnace is charged with ſow and pig metal, or any other ſort of caſt iron, the door or doors of the furnace ſhould be cloſed, till the metal is ſufficiently fuſed; and, when the work-

man

man difcovers (through a hole which he opens occafionally) that the heat of the furnace has made a fufficient impreffion upon the metal, he opens a fmall aperture or apertures, which I find is convenient to have provided in the bottom of the doors, (which is or are clofely fhut, as well as the doors, at the firft charge of the furnace with cold caft metal,) and then the whole is worked and moved about, through thofe apertures, by means of iron bars, and other inftruments fitly fhaped; and that operation is continued, in fuch manner as may be requifite, during the remainder of the procefs. After the metal has been fome time in a diffolved ftate, an ebullition, effervefcence, or fuch like inteftine motion takes place, during the continuance of which a bluifh flame or vapour is emitted; and, during the remainder of the procefs, the operation is continued (as occafion may require) of raking, feparating, ftirring, and fpreading the whole about in the furnace, till it lofes its fufibility, and is flourifhed, or brought into nature; to produce which effect the operations fubfequent to the fufed ftate are the fame, whether the fufion be

 made

made in the air-furnace, or the metal be conveyed into it in the fused state, as first mentioned. As soon as the iron is sufficiently in nature, it is to be collected together in lumps, called loops, of sizes suited to the intended uses, and so drawn out of the door or doors of the furnace; when all the small pieces that may happen to remain are also cleared away. It has been found by me to be a good method of using such small pieces last mentioned, (and also scull or cinder iron, first broken into small pieces, and likewise all sorts of parings of iron plate, or other thin iron, and bushel iron, commonly called wrought scraps,) to throw them into the furnace in various proportions, during the operation of bringing the fused metal into nature, and before it is collected into loops; and, as the whole charge of the furnace is raked and stirred about, these scraps become lapped up in the loops, after the fused metal is flourished, and got into nature. And the whole of the above part of my method and process of preparing, manufacturing, and working of iron, is substituted instead of the use of the finery, and is my invention, and was never before used or put

in practice by any other perſon or perſons. The iron ſo prepared and made may be afterwards ſtamped into plates, and piled, or broke, or worked in an air-furnace, either by means of pots, or by piling ſuch pieces, in any of the methods ever uſed in the manufactory of iron from coke-fineries without pots; but the method and proceſs, invented and brought to perfection by me, is to continue the loops in the ſame furnace, or to put them into another air furnace or furnaces, and to heat them to a white or welding heat, and then to ſhingle them under a forge-hammer, or by other machinery, into half-blooms, ſlabe, or other forms; and theſe may be heated in the chafery, according to the old practice, but my new invention is to put them again into the ſame or other air-furnaces, or other furnaces, from which I take the half-blooms, and draw them under the forge-hammer, or otherwiſe, as laſt aforeſaid, into anconies, bars, half-flats, ſmall ſquared tilted rods for wire, or ſuch uſes as may be required; and the ſlabe, having been ſhingled in the foregoing part of the proceſs to the ſizes of the grooves in my rollers, through which

which it is intended to be paſſed, is worked by me through the grooved rollers, in the manner in which I uſe bar or wrought iron, faggoted and heated to a welding heat for that purpoſe; which manner of working any ſort of iron, in a white or welding heat, through grooved rollers, is entirely my own invention. Iron, and alſo ſteel, ſo prepared, made, wrought, and manufactured, by ſuch effectual application of fire and machinery, will be diſcharged of the impurities, and foreign matter, which adhere to them when manufactured in the methods commonly practiſed. The ſteel is of an excellent quality, and the iron will be found to be good tough iron, in bars and uſes, whether large or ſmall; and all ſorts of merchant iron, whether it be made from metal of a red-ſhort or cold-ſhort nature, and bliſtered ſteel, whether made from iron prepared according to the above proceſs or from any other iron, when faggoted together, heated to a white or welding heat, rolled in that heat through grooved rollers, according to the method invented by me, and ſlit through the common cutters, is equal to ſteel manufactured by forge and tilt hammers.

The

The whole of which diſcovery and attainment are produced by a more effectual application of fire and machinery, as deſcribed by me, than was before known of, or uſed by others, and are entirely new, and contrary to all received opinions amongſt perſons converſant in the manufactory of iron; and the whole of my method may be completed without the neceſſity of uſing finery, charcoal, coke, chafery, or hollow fire; and without requiring any blaſt by bellows, or cylinders, or otherwiſe; or the uſe of fluxes, in any part of the proceſs. The whole operation to be performed with one or more furnaces, according to the quantities or diſpatch required. In witneſs whereof, &c.

L. *Specification of the Patent granted to Mr. Joseph Bramah, of Piccadilly, Engine-Maker; for ſeveral Improvements and Additions to a Fire-Engine originally invented by him, and for which a Patent was obtained* *.

WITH TWO PLATES.

Dated April 18, 1793.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Joſeph Bramah do hereby declare, that my ſaid invention is deſcribed in the plan or drawings hereunto annexed, and in the deſcription following; that is to ſay, Fig. 1. (Plate XXI.) repreſents a cylindrical veſſel, made of wood, and may be of greater or leſs dimenſions, according to the intended ſize of the engine; theſe drawings are to a ſcale of three-fourths of an inch to the foot, which is ſufficient for an engine of the

* The whole machine is deſcribed in this Specification, in ſuch a manner as to render a reference to the former patent unneceſſary.

largeſt

largeſt common ſize *. This veſſel is compoſed of ſtaves, heads, and iron hoops, the ſame as any other piece of coopers work made for holding liquor; the hoops differ from thoſe of a common veſſel, being made to tighten with a ſcrew, as at B in hoop A, as the veſſel, being cylindrical, cannot be hooped with driving-hoops, in the uſual manner. C C are two ſlits, through which the levers paſs which receive the handles of the engine. (See ſection.) At D is a man-hole, ſufficiently large to admit a man into the inſide of the veſſel occaſionally, if required; this hole is ſhut up, when the veſſel is full of water, by a bung compoſed of the ſame piece which is cut out of it, being cut bevelling outwards, as at D, Fig. 2, and having nailed round its edge ſome leather, or other ſoft material, for rendering the junction water-tight. Fig. 2 and 3 are the ſide and end ſections; ſhewing the true conſtruction of the veſſel, Fig. 1, and alſo how the patent-pump, or hydraulic part, is fixed and connected therewith;

* Our figures are reduced to about half the dimenſions of thoſe here referred to.

 and

and how the engine is to be filled with water and worked; likewiſe a deſcription of the carriage on which the engine is conveyed, and how mounted thereon. N. B. the ſame letters of reference are uſed to the ſame parts, in both ſections.) E E, Fig. 2, ſhew the two heads of the veſſel, which are grooved into the ſides of the cylinder, at proper diſtances from each end, ſo as to leave room at one end for the reception of the patent-pump, and one of the handle-levers; and, at the other end, room for the lever only. Between the heads E E is a ſpace, which forms the interior of the veſſel or reſervoir F, capacious enough to hold, in this large engine, five hogsheads of water, ale-meaſure. G ſhews the patent engine-pump, with one end of its axis paſſing through the head E, in the centre of the cylinder; it is faſtened, and made water-tight, by being ſcrewed down to the head E, all round one of its flanches, (with a leather between the flanch and the head,) with the ſcrews *h h*, &c. H is an iron ſpindle, which is connected with the axis of the pump at L, at one end, and the other end paſſes through a ſtuffing-box at K, fixed in the

head

head E, which caufes it to be water-tight. In the fpace M the handle-lever is joined to the fpindle, by being driven up to a fquare, or otherwife; the fpindle H is continued on to the exterior head N, and has a pivot which falls into the bufh O; this handle-lever moves in the flit C, which, being of a proper length, prevents the handle from being moved too far in their direction. The other handle-lever is joined to the axis of the pump, in the ufual way, and works as reprefented at the pump end of the cylinder, at R. P fhews the handle of the engine, difcontinued at Q, that it may not interfere with the other parts. S is a fliding-cock, which opens and fhuts the forcing arm, that communicates, for the purpofe of filling the refervoir, by the pumping of the engine from her own fuction. T is the fuction-cock, one arm of which communicates with the refervoir at U, and the other arm externally at V, where there is a fcrew to receive the fuction-pipe W. X is the handle of the cock, which, being turned one way, opens a communication to the refervoir; and, when turned the reverfe way, opens a communication to the fuction pipe W; fo that the en-

 gine

gine will work, either by a ſupply from the reſervoir F, or by a ſupply from the ſuction-pipe W, in the uſual way. N N are the two external ends or heads, which cap in all the works of the engine, and in which the braſs buſhes or bearings O O are fixed, for the ſupport of the axis of the engine, and ſpindle H. Y is the forcing-arm, paſſing through the head N, on the outſide of which is a ſcrew for the reception of the hoſe-pipe, as uſual in other engines: there is alſo a braſs cap, (ſee chains *v v*,) which ſcrews on to this part, when the reſervoir is filled through the cock S. Z is a box, fixed on the upper ſide of the cylinder F, made with a lid, for the purpoſe of containing the hoſe-pipes, and various other implements belonging to the engine: there is a partition at *b*, for the ſecurity of the air-veſſel. *a a* are blocks, hollowed out on the upper ſide, ſo as to exactly fit the circle of the cylinder F, as appears at *a* in the end ſection, Fig. 3; theſe blocks are firmly fixed to the cylinder with iron bolts, &c. When the machine is thus prepared, it is mounted on a carriage with four wheels, as in the ſection Fig. 2, which is drawn by the ſame

ſcale

ſcale as the parts already deſcribed, and is ſo plainly delineated as to require no deſcription in words; the only particular to be attended to in making this carriage is the height of the wheels, ſo that the centre of the cylinder, and the axis of the engine O O, may remain in proper height for the handles which work the engine. In all other reſpects the form and manner of making the carriage may be varied, without interfering with the merits of the engine: the carriage may be made ſimilar to that of a coach, caravan, or common waggon, and with equal effect, with reſpect to the utility of the engine. Fig. 4, (Plate XXII.) repreſents a perforated boſs or noſe to the branch of the engine, made of copper, or other proper metal, for the purpoſe of occaſionally ſpreading or diſperſing the jet of water in many directions at the ſame time. Fig. 5, is the ſide view of the boſs or noſe, Fig. 4, ſhewing that the underſide of it is not perforated, no diſcharge of water downward being neceſſary, on account of the immediate deſcent of that which is thrown upwards; by this a waſte of water is prevented. The holes, perforated in this boſs or noſe, muſt be of larger dimen-

ſions

fions than thofe in the colander of the fuction-pipe W, to prevent the bofs from choaking with what paffes through the engine when the water is dirty; about five-fixteenths of an inch in diameter will be, in general, a proper fize for a large engine. This bofs or nofe is meant to be ufed in fuch cafes as will admit of a near approach to the part where the fire is firft begun, or at any other period when deemed ufeful; at other times the engine is ufed with the ufual nofe-pipe. Fig. 6 is a fquare, in which is difplayed in perfpective, both individually and collectively, all the parts which compofe the pump or hydraulic part of the engine in its moft perfect ftate, with all the improvements that have been progreffively made fince the firft patent was obtained, and which are inferted here only to fhew the principle of the whole machine, without reference to the former fpecification. A, Fig. 6, is the cylinder in which the act of pumping is performed; having a flanch at each end, to which are fcrewed the two caps or end heads of the cylinder. B is the axis, which is armed with two wings or fans, in each of which is a valve for the admiffion of the water

 through

through them; all round the external edge of theſe wings is ſcrewed a narrow plate, under which is leather, to render the wings or fans, which move againſt the interior ſurface of the cylinder, water-proof. C is a partition, the lower edge of which is joined to the cylinder, and the upper edge is made ſo as to exactly fit the circle of the axis; the half of which axis is always below the thickneſs of the wings or fans, as appears in the collective drawing F, at *a*. In the upper edge of the partition C is a groove, as at *b*; when the axis is fixed in its place, this groove *b* is filled with junk, or ſome other ſoft material, ſo as to preſs on the axis, and cauſe it to move water-tight; this partition C divides the lower part of the cylinder, next the ſuction, into two compartments, in which, on each ſide the partition C, is cut, in the cylinder, an aperture which opens to the ſuction-pipe at G; theſe apertures are opened and ſhut by two valves, as repreſented in drawing F, at DD; and *d* repreſents one of the valves DD. E is a wedge which, paſſing through the ſtaples or loops *c c*, in the partition C, faſtens the valves. F, in the collective

lective drawing, ſhews the diſpoſition of all the interior parts when put together. K repreſents a circular plate, one of which fits into a rabbet in each end of the cylinder A, through which plate the axis B paſſes in a ſtuffing-box, at L, which cauſes it to move water-tight. In each plate there is a ſlit, as at M, which, receiving each end of the partition C, makes it ſtrong; and when the cap N is ſcrewed down to the flanch at each end of the cylinder, with a leather between it and the plate K, the whole is incloſed intirely water-proof. O is the nut of the ſtuffing-box L, which, being ſcrewed down upon the ſtuffing, in the box L, completes the whole. In witneſs whereof, &c.

LI.

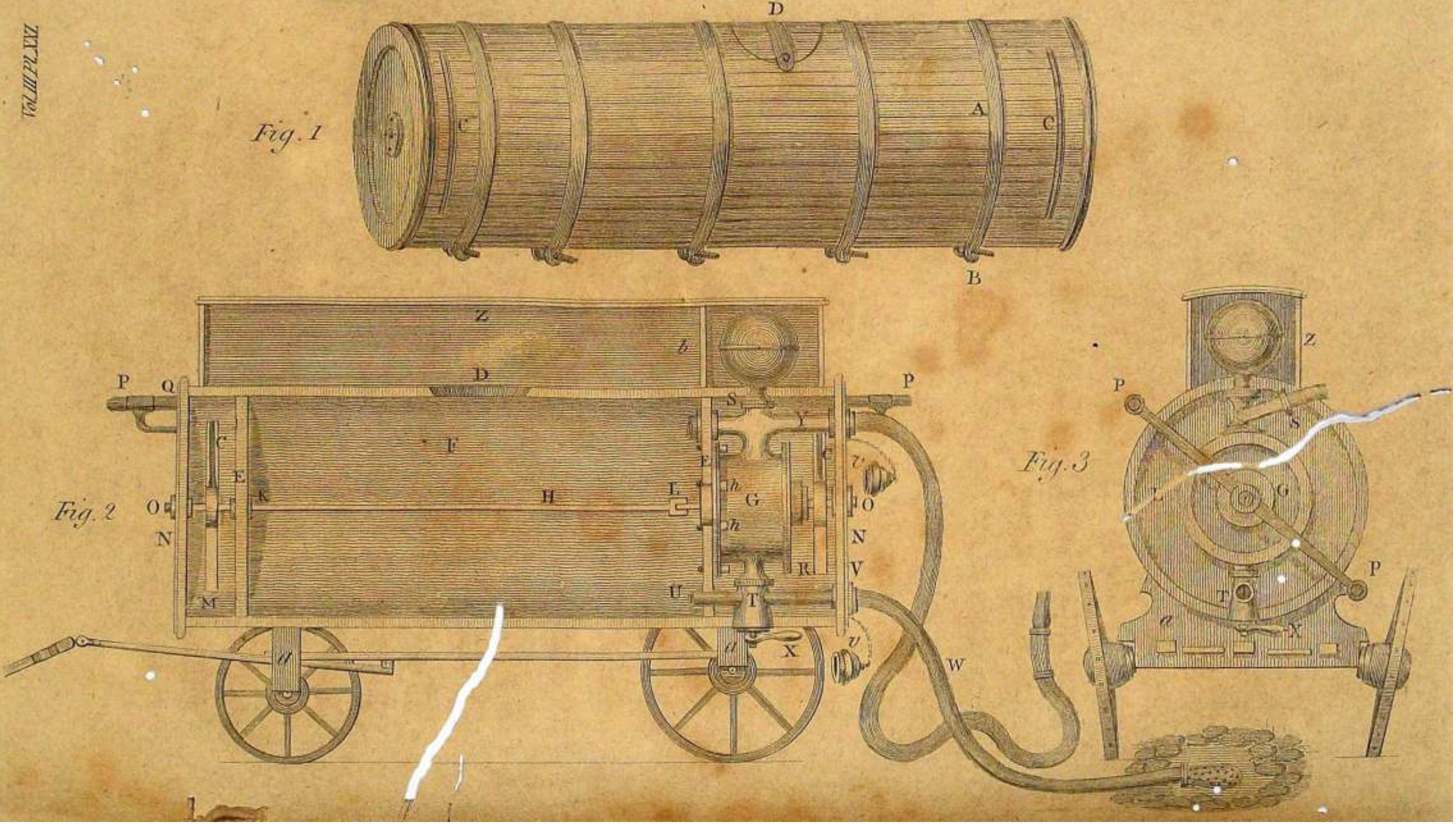


Fig. 1
D
C
A
C
B
Fig. 2
Z
b
D
P
Q
P
S
Y
F
C
E
E
C
K
H
L
G
h
h
O
O
N
N
R
V
M
U
T
u
u
X
v
v
W
Fig. 3
Z
P
S
G
P
T
X
a

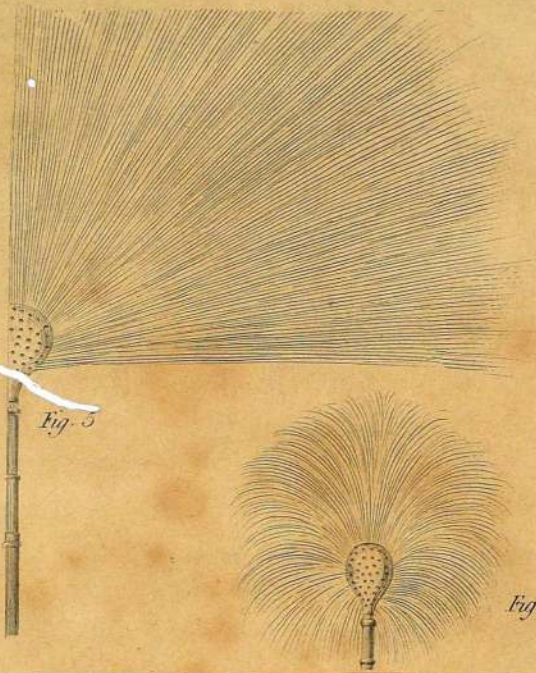
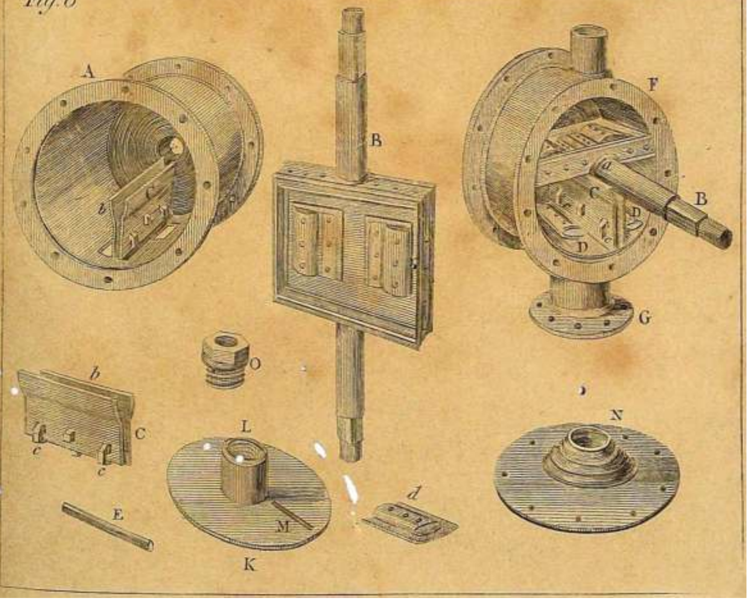


Fig. 3

Fig 4

Fig. 6



LI. *Specification of the Patent granted to Mr.* SAMUEL HOOPER, *of the Pariſh of St. Giles's in the Fields, Bookſeller and Stationer; for his Invention of a new Method of making and manufacturing Printing-Paper, particularly for Copper-Plate printing.*

Dated September 17, 1787.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid Proviſo, I the ſaid Samuel Hooper do hereby declare, that the printing-paper made and manufactured according to this my invention is much ſuperior to any hitherto made in this country; and is alſo much ſuperior in colour, and in every reſpect, in point of quality, equal to the beſt paper made in France; and free from ſpecks and iron-moulds, to which the French paper is in general very much ſubject, to the great trouble and loſs

of the printers in clearing it from its foulneſs before they can uſe it, eſpecially for fine prints, which otherwiſe, by a ſpeck or iron-mould being left in the paper, and coming particularly in the light parts, is ſure to ſpoil them; all which defects are intirely remedied by the mode herein deſcribed. The paper upon this principle is alſo a great advantage to the print itſelf, as the ſurface is never raiſed by picking out the foul parts, as is well known to be abſolutely neceſſary in the French paper. It has alſo another advantage over the French paper, by being made on wove-moulds, which gives the whole ſheet an equal ſurface; whereas the French, being made on common moulds, leaves the wire-mark, which prevents an equal ſurface. The manner in which the paper, as herein deſcribed, is to be made, is as follows; that is to ſay, the uſual and cuſtomary method hitherto uſed for making of paper, and with the accuſtomed materials, is to be purſued until the rags are prepared in the engine; when the materials after mentioned are to be introduced, in the proportion or quantity herein directed, for the quantity

quantity of rags herein mentioned, and ſo in proportion for a greater or leſs quantity of rags; that is to ſay, to one hundred weight of the beſt rags, prepared in the engine till fit to make into paper, take forty pounds weight of alabaſter or plaſter, ten pounds weight of talc or talk, and ten pounds weight of plaſter of Paris, (which is of a more binding quality than the Engliſh,) all of which muſt be calcined, and reduced to a powder; to theſe add twelve pounds of the beſt white ſugar-candy pounded; put theſe into the engine, and let them be incorporated with the pulp of the rag, with a ſufficient quantity of ſize, made from rice and pearl-barley, to give the paper firmneſs. But, in ſome caſes, it may be found neceſſary to vary the quantity of powder, that is, according to the kind or quality of the paper you want; for, a thin paper will take leſs, and a thick one require more, powder: and this variation will depend not altogether on the quality of the rags, but likewiſe on that which it is indiſpenſably neceſſary to give the paper, ſo as to anſwer its particular purpoſe, and for what kind of printing it is wanted; this done, it will pro-

duce paper of the colour and quality as herein before deſcribed. The ſeveral articles of alabaſter, talc or talk, and plaſter of Paris, may be either of them ſeparately uſed for the purpoſe, being nearly of a ſimilar nature; and then in the proportion of half a hundred weight of alabaſter, talc or talk, or plaſter of Paris, to a hundred weight of rags, to be calcined and reduced to a powder, and uſed with the materials, and in other reſpects as before mentioned; but the mixture of the ſeveral articles together, as herein deſcribed, produces the beſt effect. In witneſs whereof, &c.

LII. *Specification of the Patent granted to Mr.* ALBERT ANGELL, *of Bethnal Green, in the County of Middlesex; for his Invention called Britannic Elastic Gum; very serviceable and useful in the several Branches of Portrait and House Painting, by making the Colours durable and free from peeling; also of great Utility in gilding, painting, penciling, and staining of Silks, Calicos, &c. and in dressing of Silk, Linen, and Cotton, in the Loom, instead of Gum or Paste, so as to strengthen the Threads of the finest Cottons; and is also excellent for beautifying and fixing the Colours upon Paper, equal to that done in India; and is of the greatest Use for rendering the Clay, or Composition, used in modeling, supple, and preventing the same from drying too fast; and for causing a Transparency of Colours, fit for China and Earthen Ware, so as to stand baking or burning.*

Dated Jan. 24, 1781.—Term expired.

TO all to whom these presents shall come, &c. Now KNOW YE, that he the said Albert Angell, in

in purſuance of the intention of the ſaid letters patent, and in compliance with the proviſo therein contained, doth hereby declare, that the nature of his ſaid invention, called Britannic Elaſtic Gum, and in what manner the ſame is to be performed, is deſcribed and aſcertained in manner following; that is to ſay, linſeed-oil, or nut-oil, one gallon; bees wax, yellow or bleached, one pound; glue, or ſize, ſix pounds; verdegris a quarter of a pound; litharge a quarter of a pound; ſpring or rain water two quarts; to be put into an iron kettle, and melted down till it comes to the compoſition. In witneſs whereof, &c.

LIII. *Experiments and Obſervations on the conſtituent Parts of the Potatoe-Root;* by GEORGE PEARSON, *M.D. F.R.S.*

From the Report of the Committee of the Board of Agriculture, concerning the Culture and Uſe of Potatoes.

THE Board of Agriculture having requeſted me to enquire into the compoſition, or parts, of which the potatoe-root conſiſts; and particularly to aſcertain the proportion and nature of the watery part; I have now the honour of laying before the Board the following experiments and obſervations.

It will be proper firſt to obſerve, that the ſort of potatoe-root uſed in theſe experiments was that well known by the name of *kidney potatoe*; and that the ſkin was taken off by paring it in the uſual way.

Experi-

Experiment I. 3500 grains of potatoe-roots, cut into ſlices of about one-eighth to one-twelfth of an inch in thickneſs, after expoſure in a large glaſs diſh to the heat of the ſteam of a water-bath, of 190 to 200 degrees of Fahrenheit's thermometer, afforded 1000 grains of a very brittle, hard, heavy ſubſtance. Some pieces of this ſubſtance were whitiſh, others brown, and many of them alſo were black, being a little burnt.

Experiment II. On a repetition of the preceding experiment, the reſult was nearly the ſame; 3500 grains of potatoe-roots affording about 1000 grains of hard brittle ſubſtance.

Experiment III. 7000 grains of ſliced potatoe-roots, treated as in the preceding experiments, yielded 2100 grains of dry brittle matter.

Experiment IV. 3000 grains of ſliced potatoe-roots, being evaporated in a ſand-bath, of a higher temperature than the water-bath, there remained 900 grains of brittle, dry, hard pieces of matter; moſt of which were burnt a little, and black.

Experiment V. The whitiſh and unburnt dried ſlices of potatoe-roots, being ground to powder,

afforded

afforded a greyifh meal or farina, of the tafte of raw potatoe-root, of about the fame fpecific gravity, and drier than meal of wheat in its ufual ftate.

From the above experiments it appears that potatoe-roots afford about two-fevenths of their weight, or twenty-eight to thirty *per cent.* of meal. Hence, if a bufhel of thefe roots weigh feventy-five pounds, it fhould yield twenty-one or twenty-two pounds of meal.

Experiment VI. 17500 grains, or three pounds and half an ounce, troy-weight, of fliced potatoe-roots, were diftilled to drynefs, by the heat of the fteam of water.

The diftilled liquid amounted to 13000 grains, or about 27 ounces, and meafured near one pint and ten ounces. The dry matter in the retort weighed nearly 4500 grains.

The diftilled liquid was clear and colourlefs as rock-water; it had the fmell of the potatoe-root, and alfo a flight empyreumatic fmell; it had no tafte; it did not alter the colour of paper ftained with turnfol, nor that with turmeric. Being evaporated to drynefs, a quantity of refidue was left

 behind,

behind, but much too ſmall in quantity to be collected and weighed; it ſeemed to be common ſalt, which I imputed to the water with which the receiver had been waſhed. This diſtilled liquid may therefore be conſidered to be pure water, excepting the impregnation with a little eſſential or volatile, and perhaps empyreumatic, oil.

Experiment VII. A quantity of potatoe-roots was raſped; and in this ſtate they reſembled curdy matter in watery liquid. Of theſe raſped potatoes 7000 grains were mixed with four pints of river-water. After being macerated twenty-four hours, during which time the mixture was frequently ſtirred, a clear dark-brown liquid, of the ſmell of potatoe-root, poſſeſſing neither acid nor alkaline properties, was poured off; leaving behind a large proportion of leafy or fibrous ſubſtance, and a precipitate of white impalpable powder. This white precipitate and fibrous ſubſtance were macerated repeatedly, with freſh portions of water, till the decanted liquor was colourleſs, and without ſmell or taſte. The fibrous ſubſtance and white precipitate, being mixed with water, were poured upon a fine hair-ſieve, through which

the

the water paſſed, carrying with it the white precipitate; the fibrous matter was left behind. The white ſediment, depoſited from the filtrated water on ſtanding, being collected and dried, weighed 1050 grains: it had the obvious or ſenſible properties of ſtarch of wheat, and afforded a tranſparent jelly with boiling-water. The leafy and fibrous ſubſtance, being dried, formed ſmall, hard, brittle, irregular-figured, maſſes, which amounted in weight to 600 grains. A pint of the firſt filtrated brown liquid, poured off from the leafy ſubſtance and white precipitate, being evaporated, an extract was obtained, which had a ſtrong ſmell of potatoes, and of empyreuma. It had a ſlight ſaltiſh taſte; but, to the teſt of turnſol and turmeric, betrayed no acid nor alkaline properties. The whole extract of ſoluble mucilage in 7000 grains of potatoe-root, by eſtimation, was from 350 to 400 grains: of courſe, the quantity of water in this quantity of potatoe-root was about 5000 grains.

Experiment VIII. A little of the dried leafy ſubſtance obtained in the laſt experiment, and alſo a little of the extract, emitted, while burning,

the ſmell of farinaceous ſubſtances, and not at all that of animal matter in general, or of glue of wheat in particular.

Experiment IX. A bit of paper ſtained blue by turnſol, being applied to a ſlice of potatoe-root, was inſtantly turned to a red colour.

Experiment X. 1000 grains of potatoe-roots being burnt in an open crucible, fifteen grains of aſhes were left, which conſiſted principally of mild potaſh, probably mixed with earth, oxide or calx of iron, and of manganeſe, common ſalt, and perhaps phoſphoric acid united to lime.

Concluſions and Remarks.

1. It appears from the above experiments (I—VII.) that 100 parts of potatoe-root, deprived of its ſkin or bran, conſiſt of

1. Water, - - -	68	to	72
2. Meal, - - -	32	to	28
	100		100

2. The

2. The meal confifts of three different fubftances:

1. Starch or fecula,	-	17	to	15
2. Leafy or fibrous matter,		9	to	8
3. Extract or foluble mucilage,		6	to	5
		32		28

3. The potatoe-root contains alfo potafh, or vegetable alkali. (Experiment X.) By eftimation, there were ten grains of it, in its mild ftate, from 1000 grains of the root; but as, of thefe ten grains, not lefs than two and a half were carbonic acid or fixed air, produced during burning, we cannot reckon the quantity of this alkali more than feven grains and a half in 1000 of the root; that is, three-fourths of a grain *per cent.*

4. The afhes of 1000 grains of potatoe-roots afforded alfo feven grains and a half, or three-fourths of a grain *per cent.* of fubftances not examined; (Experiment X.) but which are very probably

probably the ſame as are afforded by the aſhes of vegetable matters in general; namely, oxide or calx of iron, and of manganeſe, phoſphoric acid united to lime, magneſia, and muriate of ſoda or common ſalt.

5. The ſubſtances found in the aſhes of 1000 grains of the potatoe-root, amounting to fifteen grains, (Experiment X.) do not, we have good reaſon to believe, enter into the compoſition, that is, are not eſſential conſtituent parts of the root; but are merely extraneous matters, introduced into the plant along with water, air, and other aliment; or are ſecreted by the powers of the vegetable œconomy.

6. There is alſo, in the root under examination, volatile eſſential oil or *ſpiritus rector*, to which are owing its ſmell, and what little taſte it poſſeſſes. The proportion of volatile oil is too ſmall even to be eſtimated; and moſt of it ſeems to fly off with the water during diſtillation, or evaporation. The greateſt part, or the whole, of this oil, may be waſhed out along with the extract or ſoluble mucilage, as appears from Experiment VII.

7. There

7. There is in the juice or water of the potatoe-root an acid, (Experiment IX.) which diſappears upon burning the root to aſhes; (Experiment X.) either becauſe it is decompounded by the fire, or evaporated, or becauſe it enters into chemical union during the combuſtion. This acid is not diſcoverable in the filtrated liquor from the bruiſed root, becauſe the proportion of it is too ſmall to be detected by any teſt, when diluted with water, as in Experiment VII.

Having ſtated what are the kinds, and proportions, of the different ſubſtances contained in the root under examination, it will be uſeful to conſider the mode of junction of theſe with one another.

8. The above experiments, eſpecially experiment VII. ſhew that the potatoe-root is what is termed in chemiſtry a mechanical mixture, conſiſting of water, ſtarch or fecula, leafy or fibrous matter, and extract or ſoluble mucilage; for, theſe ſubſtances were ſeparated fron one another by mechanical means. The ſalts, earths, and metallic oxides or calces, (Experiment X.) and volatile oil, (Experiment VI. and VII.) are indeed probably united to the water;

ter; but theſe are not conſidered as eſſential conſtituent parts of the root under examination.

9. The compoſition, or more properly the mixture, of the potatoe-root, is in many reſpects ſimilar to that of the ſeed of wheat, and of maize. We are indebted to James Bartholomew Beccari, profeſſor of chemiſtry at Bologna, about ſeventy years ago, for the important diſcovery that the meal of wheat, and of maize, contained not only ſtarch, but alſo a ſoluble mucilage or extract, and a glue of the ſame nature as animal matter. Theſe three ſubſtances are only mechanically mixed with one another. The glue is not capable of the ſaccharine, vinous, or acid, fermentation; but, like animal matter, putrifies. It alſo affords ammoniac or volatile alkali on diſtillation; and, on burning, emits the peculiar ſmell, and gives the other products, of animal ſubſtances; neither does it afford potaſh, like vegetable ſubſtances. Beccari, in his account of it, ſays, "Maſſa mol-"lis, ſupra quam credi poteſt tenax; egregium "glutinis genus, et ad opificia multa aptiſſi-"mum." The principal and eſſential difference

between

between the meal of wheat and potatoes is, that the former contains animal matter, and the latter, in place of it, a leafy or fibrous vegetable matter; but the principal ingredient, in point of quantity, in both kinds of meal, is ſtarch; and they both afford an extract, or contain a ſoluble mucilage. The proportion of the animal glue of wheat is ſtated variouſly in different experiments; but the general mean reſult appears to be, that it is about one-twelfth of the meal. To this glue is imputed the ſuperior quality of wheat-meal for bread. It is ſuppoſed to give tenacity and firmneſs, and at the ſame time promotes the fermentation, in making bread; as well as gives it a taſte.

10. The contemplation of the nature of the conſtituent parts of the potatoe-root, and of other kinds of meal, is perhaps more intereſting to medicine and chemiſtry than to the branch of knowledge called œconomy: it is, however, immediately relative to the object of the Board to obſerve, that we may ſafely conclude that ninety-eight or ninety-nine parts, out of a hundred, of

 the

the meal of the potatoe-root are convertible, or capable of being aſſimilated, into animal matter.

11. With reſpect to the comparative quantity of nouriſhment afforded by potatoe-meal, ſeveral eminent writers have aſſerted, (but, I believe, from analogy rather than actual obſervation,) that wheat-meal, and bread of wheat, are more nouriſhing than an equal weight of other kinds of meal, or bread. This concluſion has been made from the fact that the meal of wheat contains animal matter, whereas the other kinds, except the meal of maize, contain none at all, or an extremely ſmall proportion It appears, however, by abundant evidence, that men who are nouriſhed by vegetable food alone, are as long-lived and healthy, and are furniſhed with organs, and perform the functions of the animal œconomy, as perfectly, as other men who are nouriſhed by animal food, or by a mixture of animal and vegetable food. There is alſo ſufficient evidence, in many parts of this kingdom and Ireland, that the potatoe-root and water, with common ſalt, or other ſeaſoning, can nouriſh as well as any other

vegetable matter and water, with feafoning. It might indeed have been concluded, from analogy, that the potatoe-root is capable of affording adequate nourifhment; for, the principal vegetable nutriment of mankind is meal, and efpecially thofe kinds of meal which contain no animal matter; and the principal, as well as effential, ingredient of meal is ftarch; of which fubftance the farina of the potatoe-root contains more than half its weight: a proportion not much, if at all, inferior to that in other kinds of meal in general ufe.

I cannot therefore find any juft ground for the opinion, that the meal of wheat muft afford much more nourifhment than an equal quantity of potatoe-meal; for, if it be granted that this muft be the cafe becaufe the former contains animal matter, it is reafonable to believe that the proportion of the animal matter is too fmall to occafion a confiderable difference between the nutritive properties of wheat and thofe of other meals. But it appears, from fome experiments of feeding animals upon the glue or animal part of wheat, and

upon the meal freed from this animal matter, that the former is much leſs nutritive than the latter.

It is alſo, I believe, a fact, and one of great importance, that potatoes and water alone, with common ſalt, can nouriſh men completely; but other mealy ſubſtances, although the principal food of millions of the human race, who never taſte animal ſubſtances, are always mixed with other kinds of alimentary matter; ſuch as oil, fruits, whey, milk, ſour milk.

12. To prepare potatoe-meal of the beſt quality, the ſliced roots ſhould be dried in a much lower temperature than in the above Experiments, (I.—IV. V.) otherwiſe it will be brown, or blackiſh, and have an empyreumatic taſte. The thinner the ſlices, the more ſpeedily, under equal circumſtances, will the roots be dried: they will dry very ſpeedily upon a net, ſuſpended in the air of a kiln, of the temperature of about 110 to 130 degrees. I think it will be beſt not to pare off the ſkin, as probably it principally contains the volatile or eſſential oil, which gives an agreeable flavour: nor is there any reaſon to ſuppoſe

that

that the ſkin is not alimentary, or that it poſſeſſes noxious qualities.

It has been propoſed to dry raſped potatoe-roots, after draining off the watery liquid; but the meal ſo obtained will have been deprived of the greateſt part, or all, of one of the ingredients of the root, namely, the ſoluble mucilage; which alone is undoubtedly nutritive, and probably may, by its mixture with the other conſtituents parts of the potatoe-root, render them more nutritive, and be rendered ſo by them.

13. There is, I apprehend, no reaſonable doubt that potatoe-meal may be uſed for preparing the different ſorts of ſtarch, diſtinguiſhed by the names of ſago, tapioca, vermicelli, macaroni, ſalep, common ſtarch; and ſerve for infinitely various compoſitions of cookery, ſuch as puddings, biſcuits, paſtes. The art of fermenting potatoe-meal into bread, in place of wheat, has not yet been diſcovered; but excellent bread can be made by a mixture of about three parts, or perhaps of two parts, of meal of wheat, and one part of potatoe-meal; or by a mixture of due proportions of the root itſelf, and wheat-meal.

It

It has been ſaid, that good bread may be made of a mixture of potatoe-meal, or root, and the bran of wheat. It is a matter of curioſity, and might be uſeful, to try to make bread of potatoe-meal, mixed with the glue or animal part of wheat; which is a reſidue of very little value at preſent in the ſtarch manufactories.

14. It is, however, moſt profitable, and perhaps ſalutary, to uſe the potatoe-root, for food, cooked by merely boiling, or baking: it is obvious that it is the ſimpleſt and cheapeſt preparation. In this way the meal is taken into the ſtomach, more intimately mixed or diffuſed through two and a half, or three times, its weight of water, than is the caſe with artificial mixtures of the meal and water. Hence the eaſineſs of digeſtion, and lightneſs, of this root, above other farinaceous ſubſtances equally nutritive. Hence alſo this root alone, or with the addition of a ſmall proportion of meat, or oil, can afford ſufficient nouriſhment to moſt perſons, without diſordering the ſtomach by its bulk; as is the caſe with the white beet, turnip, onion, and other roots which contain a

much

much larger proportion of water than the root of the potatoe.

It is well known that potatoe-roots are eaſily kept for many months, without being ſpoiled by growing, or putrefaction; and, at the ſame time, retain the greateſt part, or the whole, of the water of the freſh root.

There is good reaſon to believe, that cuſtom would ſoon render boiled or baked potatoes as agreeable to the palate as bread; and that they might ſupply its place at dinners of animal food, in many caſes, with deciſive advantages.

15. The potatoe-root may be rendered more nutritive by malting. Malting is an operation of the vegetable œconomy, during growth, by which taſteleſs meal is changed into ſweet mucilage, called ſugar. However agreeable to the palate, occaſionally, this preparation may be, it cannot be of ſuch extenſive uſe as the meal; for, like all ſtrong-taſting mucilages, by repeated uſe it palls the appetite. Like them therefore it can, in general, only be uſed occaſionally, and to render other kinds of food ſavoury. On this

account

account ſome of the moſt nutritive vegetable ſubſtances, ſuch as carrots and parſnip-roots, the juice of the ſugar-graſs, honey, &c. cannot ſupply the place of potatoe and other meals, although they are more nutritive. Fat oil alſo, although more nutritive than farinaceous ſubſtances, cannot ſuperſede their uſe; becauſe, alone, it ſoon palls the appetite.

The more extenſive cultivation of the above, and other *ſaccharine roots*, and of vegetables which furniſh *oil*, muſt neceſſarily ſerve very eſſentially to render food plentiful; and they will be agreeable or gratifying to the palate, provided they be mixed with due proportions of *farinaceous* ſubſtances.

LIV. *Description of a Steam-Engine*; *by* John Cooke, *Esq. M. R. I. A.*

WITH A PLATE.

From the Transactions of the Royal Irish Academy.

STEAM is univerſally allowed to be the greateſt moving power we have, and therefore, if it were rendered manageable, and adapted to the occaſions of art, it might be advantageouſly applied where water, wind, men, or horſes, are now uſed.

Water is ſeldom convenient; wind is a feeble precarious agent; and muſcular force is very expenſive, and very limited; but ſteam is free from each of theſe imperfections, and is ſuperior to all in ſtrength and duration.

It has been already applied to work the reciprocating or lever engine, which is ſurprizingly effectual in pumping water, in beating iron, and in

in other operations which require distinct and successive impulses.

But, to make steam answer the various purposes of mechanics, it is necessary that it should be capable of producing a *continuous and rotative motion*; which itself is more extensively useful than any other, and from which every modification of motion can be easily obtained.

This machine consists of three principal parts; the wheel, represented in Fig. 1; (Plate XXIII.) the case, Fig. 2; and the condenser; which is the same with that used in Mr. Watt's engine, and requires no description. The wheel, Fig. 1, has a broad flat edge, *a b*, which is truly circular and smooth; at equal distances, on this edge, are placed eight folding clacks or valves, *b c d e f g h i*; these are attached to the wheel by small movable joints, which are so contrived that, when shut, they range exactly with the surface of the edge of the wheel, and are capable of opening half way, but no more: for instance, the valve *a n m b* has a joint at *n m*, which will permit it to open through the arch *b k l*, until it arrives at the situation *l m*, but no farther. These joints are so pliant that,

that, in the revolution of the wheel, the valves will fall open, when they defcend near the level of the axis; and, when they afcend above it, they will fhut by their own gravity.

The cafe of this wheel is reprefented in Fig. 2. The fides of it are at fuch a diftance from each other, that the wheel will exactly fill up the aperture *a b*; and the caps *c* and *d* are fo fitted, that the edge of the wheel will come in clofe contact with them. This cafe is fo much deeper than the wheel, that the wheel, when fixed in it, leaves a femicircular vacancy *e f g h* below it; which is exactly filled up by the valves of the wheel when extended. *i* is the tube to admit the fteam, and *k* is the pipe which leads to the condenfer, and drains the machine; both which muft be open, but in all other parts the cafe is fteam-tight. *a*, Fig. 3, is a rod which fhuts the valves as they approach it, and delivers them clofed into the fteam-veffel.

When the wheel is put into this cafe, and fufpended on its axis, as in Fig. 3, the valves within the cafe will open, and fill up the femicircular vacancy. When the fteam paffes up from the boiler,

 through

through the tube, it cannot escape, unless through this semicircular vacancy; and, as this is filled up by the extended valves, it must force them forward in its passage to the condenser, and consequently turn the wheel round. The condenser is worked by a crank in the axis, and a rod *b c* extending from it; this causes a constant vacuum in that part of the semicircular vacancy which lies between the cap *d* and the valve *e f*, on which the steam presses; by these means a power is added to the elasticity of the steam, equal to the pressure of the atmosphere; so that, when the force of the steam is only equal to the pressure of the atmosphere, and the valves are six inches square, the wheel will be forced round by a power equal to 531¼ lb. suspended at its circumference.

After each valve has performed this operation, another succeeds it in the like circumstances; and thus the wheel is turned round uninterruptedly, by a cheap and simple contrivance.

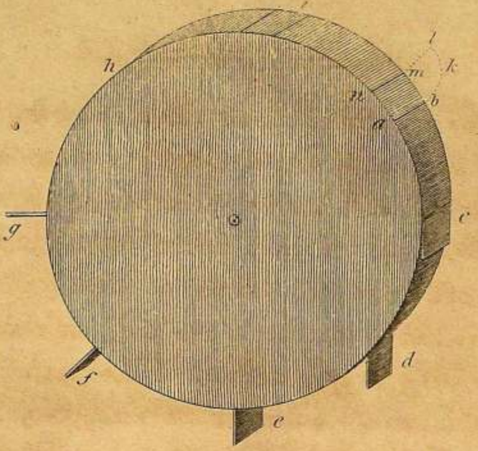


Fig. 1

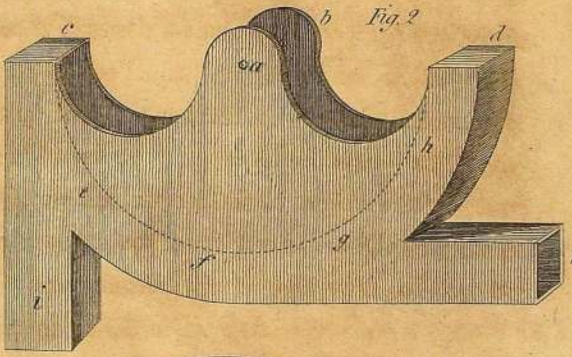


Fig. 2

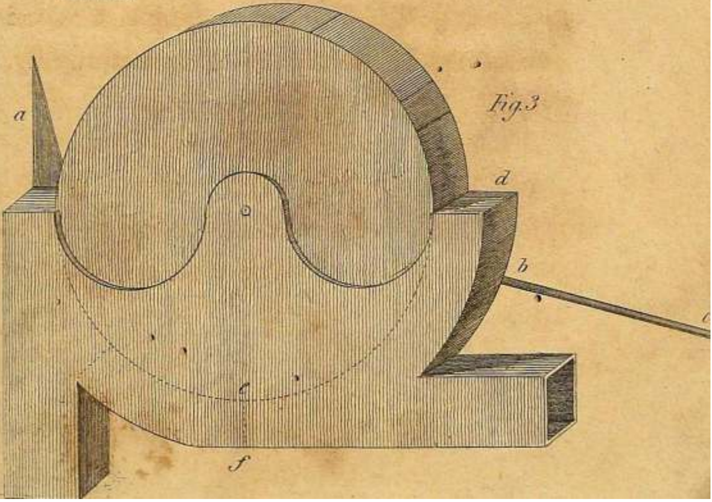


Fig. 3

LV. *Obſervations on draining Land; by Mr.* JOHN WEDGE, *of Bickenhill, near Coventry.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal of the Society was voted to Mr. WEDGE, for his Communication on the above Subject.

I HAVE the honour to be employed by the Earl of Aylesford, in taking care of ſeveral eſtates; and have, in this and former years, encouraged by his liberality, drained large portions of the land thereof; part of which is in his Lordſhip's occupation, and part, as tenant to him, in my own.

From a conſideration that the manner in which this has been done may not be unworthy of the notice of the Society for the Encouragement of Arts, Manufactures, and Commerce, I lay the following account thereof before them. Should any

any of the facts be worth communicating to the public, I beg that the Society will ſend them out in ſuch manner, or in ſuch words, as may beſt ſuit the purpoſe; and, ſhould the leaſt information be conveyed, or benefit derived, to the public, from this feeble communication, my gratification will be complete.

I have little time to read; but, in the few treatiſes on huſbandry which I have ſeen, draining land, though mentioned as one of its moſt eſſential improvements, ſeems not to be well explained. It is not my intention to obtrude much theoretic ſpeculation on the ſubject of draining: the learned ſociety, to whom the following practical facts are humbly ſubmitted, do not, I am certain, want any information in matters of theory; yet thoſe practical facts will, I hope, juſtify my preſumption in making ſome ſhort obſervations, to point out what have been leading principles to me, in my late undertakings of this ſort. In every country there are large portions of land that, in wet ſeaſons, have always what may be called a dry ſurface, and other portions of land that have always a moiſt or wet ſurface: the former of

 theſe

theſe admitting all the water which falls upon them to ſink freely through their pores, to various depths, till falling on clay, or ſome other uncтuous earth whoſe pores will not permit it to paſs through, it is there held up, to a height proportioned to the quantity of water which comes upon it, and the facility with which that water is diſcharged. Thus, held up to various heights, it ſerves as a fountain to diſtribute its water, (either by veins of ſand, pebbles, or rock,) according to the formation of the different under ſtrata on the neighbouring lands, and there forms bogs, and other varieties of wet ſurface, on a baſis that will, I believe, be always found to conſiſt of marl, or clay, or ſome mixture thereof. The effect of water, thus diſtributed, may be divided into two claſſes. The firſt claſs, where the water is thrown out by a body of marl, or clay, &c. upon the ſurface of deſcending ground, and in the valley (there held up by clay alſo) forms bogs or ſwamps. The ſecond claſs, where the water is held up by marl, or clay, as before, having, above that marl, or clay, a ſtratum of ſand, or pebbles, through which the water paſſes; and, above thoſe ſands,

or

or pebbles, another ſtratum of marl, or clay, through the weakeſt parts of which the water, by a continual preſſure from its fountain, forces a paſſage upwards; and thus, through the weakeſt parts of the marl, or clay, furniſhes a continual ſupply of water on the ſurface, for the formation or growth of bogs, &c. in proportion as this water is more or leſs abundantly ſupplied by its fountain or head, namely, the higher lands, into which rain-water freely paſſes, as before deſcribed. There are alſo different ſoils, under different circumſtances, which may form a third claſs of land for draining; ſuch as, ſtrong deep ſoils, or open light ſoils, having near the ſurface a body of marl, or clay. In either of theſe caſes, the water which falls on the ſurface muſt, for reaſons which are ſelf-evident, keep ſuch lands, in rainy ſeaſons, conſtantly wet, and cold; and it ſhould be obſerved, that a mixture of all the three before-deſcribed claſſes of wet land ſometimes occur in one field, by ſudden alterations of the under ſtrata, and thereby perplex the operator, by requiring all the different modes of draining in the ſame field.

If

If it be admitted that bogs are thus formed and fed, their cure may be effected with certainty. The firft clafs, by cutting through the ftratum (be it fand, pebbles, or rock) that conveys the water to the bog, and carrying off that water by a clofe drain, to fome proper place, where the level admits of its difcharge. The fecond clafs, by finking a drain to any convenient depth in the upper clay; and then, digging or boring, with a large auger, at a fmall diftance on one fide of this drain, through the remaining part, be it (the upper clay) ever fo deep, into the under ftratum of fand, pebbles, or rock, through which the water paffes; which will then rufh up into the drain fo made, with a velocity proportioned to the height of the land, or fountain, whence it is fupplied. As this drain advances through the land, holes muft be dug or bored, as before, every feven yards, or at fuch diftance as the ftrength of the fprings may require; and the whole of the water, thus brought up by tapping the fprings, is carried off by the drain made in the upper clay, which muft be a clofe one, to its proper level, and there difcharged.

By both theſe methods of draining, large tracts of land, under favourable circumſtances, may be cured with one drain. The beſt place, for fixing theſe drains, is where the ſtratum that conveys the water comes neareſt to the ſurface; and the beſt method of aſcertaining that is, to bore or dig in different parts, through the different under ſtrata.

The third claſs may be eaſily cured by cloſe drains, at ſuch diſtances and depths as will beſt carry off the ſurface-water. It may not be improper to obſerve, that where the different ſtrata or meaſures *crop out*, that is, become gradually more and more ſhallow in ſome certain direction, (as is often the caſe, till, one after the other, they all preſent themſelves in ſucceſſion, on the ſurface of the earth,) draining may often be much more eaſily and better effected by croſſing, with the drain, the different ſtrata or meaſures, where the levels and other circumſtances will admit.

Some of the land drained was part of a common, in the pariſh of Church Bickenhill, in the county of Warwick; part of it was covered with moſs

mofs and ling, had a peaty furface, about fix inches deep, and produced little or no grafs: in all wet feafons, it was filled quite to the furface, and often over-flowing, with water. Some of the land was much more unfound, deeper of peat, and covered with mofs, in moft parts nine inches long; another part was an abfolute bog in all feafons.

Having dug or bored, with a large auger, into feveral parts of the land, I found peat, gravel, and fand, mixed, and a quick-fand almoft uniformly. The quick-fand, in every part, after getting an inch or two into it, feemed almoft as fluid as water: judging from this, that no materials for a drain could be laid in the quick-fand, but what it would immediately bury, I dug a trench almoft to the quick-fand, leaving gravel, &c. of fufficient ftrength to bear up the materials for a hollow drain; thefe materials were, two fides, and a coverer, of ftone, with a peat-turf on the top, to keep out the foil. At every feven yards forward, by the fide of this drain, I dug a hole in the quick-fand, as deep as it would permit: from thefe holes the water rofe freely into the hol-

low drain, and was by it difcharged at a proper level. It may be proper to remark, that the ftone made ufe of for this drain, and all others here mentioned, is a red fand and rag-ftone, (from Meriden Quarry, about four miles from this place,) which eafily fplits into proper fizes for the purpofe, and is very durable; it cofts about fixpence *per* ton getting, exclufive of carriage. The drain, thus formed, ran on the whole rather freely, and made the land dry for a few yards on each fide thereof, but was far from having the effect I improperly expected; for, it evidently appears, that the drain could only take a very fmall portion of the water from fo large a quick-fand, which it did not penetrate more than two inches; and that it could drain only to its own depth, or, at moft, to that depth in the fountain which fupplied the quick-fand. My purpofe was then defeated; and my motive for mentioning this error cannot, I hope, be miftaken.

I now did what I ought to have done before, that is, examined the different ftrata to a greater depth, particularly on the bog, and at the upper edges thereof, and found the bog to be what has been

been defcribed under the firft clafs. I therefore determined to attempt the cure in the manner before prefcribed for that clafs, namely, to cut through the whole of the ftratum, (in this inftance, of quick-fand,) through which I found the water pafs; this I effected as follows; the fummer being dry, and favourable for the purpofe, and having previoufly made my main open drain, I began my main clofe drain the firft week in June, 1791, three feet wide, on the declivity near the edge of the great bog. In the firft operation we dug through the peat, the hard fand, and gravel, and one fpade's graft (about nine inches deep, and feven inches wide) into the quick-fand, the whole length of this drain, which is feventy-three perches, of eight yards to the perch, in length. The drain, thus dug, ran copioufly, not lefs than fixty gallons *per* minute; in this ftate I left it about nine days; the effect of it was rapid, both above the drain, and on the bog below. Upon examination, I now found about three inches, on the top of the fpade's graft, which had been made into the quick-fand, perfectly dry. We then dug out thefe three inches of dry fand, to nearly the

the whole width of the drain, three feet; and at the ſame time dug out, as before, another ſpade's graft from the top of the quick-ſand, as near the middle of the drain as poſſible: this was left to run a few days, as before, and had the ſame effect, namely, three or four inches more of the top of the quick-ſand became dry and hard. The ſame operation was repeated again and again, with the ſame effect, till the purpoſe of getting through this quick-ſand was completed, ſo far at leaſt as the level of the main open drain would permit. The ſtream of water continued increaſing during the whole operation; the bog below the drain was quite dry, and the land above perfectly ſo. The drain which was firſt made, and continued running for ſome time, during the progreſs of the main cloſe drain, became gradually dry; and has not, ſince that drain was finiſhed, diſcharged one ſingle drop of water. Great care was neceſſary, in making the main cloſe drain, to keep the ſtream of water in the middle of it, otherwiſe the current would have undermined the ſides, as it ſometimes had done, and cauſed them to fall in: for this reaſon it was neceſſary, when the dry

ſand was taken from the top of the quick ſand, immediately to take out a ſpade's graft from the middle thereof, in order to divert the current from the ſides.

The main cloſe drain, thus made, was three feet wide at top; about nine feet deep, on the average; and, beveling a little from the top, it was about one foot ten inches wide at bottom. The ſtone, and other materials, were put into this drain in the following manner.

Where the drain went through the quick-ſand, into the ſtratum of clay below it, as in moſt places it did, the bottom, and in ſome inſtances the ſides, wanted no particular ſecurity; but where it did not go quite through the quick-ſand, which the level of my main open drain in ſome places would not admit, the bottom of the drain was covered half an inch thick with ling; then peat-turfs, one foot wide, and three or four inches thick, were cut in convenient lengths, and placed on their edges, on each ſide the bottom of the drain, forming two ſides of a trough of peat; then ſide ſtones, about eight inches high, and a ſtone coverer, were put in upon the ling, between

 the

the peat-turfs; a large peat-turf, near two feet wide, and four inches thick, was then cut; and firmly placed over the whole; this left, in the bottom of the drain, an open ſpace, of more than ſix inches ſquare, for the water to paſs. The whole was then completed by filling in the upper part of the drain.

Fifteen acres are now ploughed for a fallow; the bog (nine acres) will now bear a horſe; but as it was, before draining, quite a pulp, I ſhall let it harden during the next ſummer before it is ploughed.

Another part of the bog is laid dry, in the ſame manner as that before deſcribed, by drains; with this difference, that the quick-ſand lay nearer the ſurface of the land, and was much thinner; therefore the drain went through it ſo far into the clay as to render ſide turfs in moſt places unneceſſary; its depth, on the average, not being more than five feet. The laſt-deſcribed land, about eight acres, I intend to plough in March, for oats. I have this day, the 20th of January, 1792, meaſured the quantity of water diſcharged through theſe drains, by ſinking a hole near the ſide of

the main open drain, and placing a caſk of known dimenſions therein; and find the diſcharge to be $50\frac{4}{10}$ gallons in one minute, or 72576 gallons in twenty-four hours. The land thus drained will, with proper cultivation, be worth at leaſt fourteen ſhillings *per* acre. The draining of theſe thirty acres of land coſt me about eighty pounds, excluſive of the ſuperfluous drain. The whole length of theſe cloſe drains is ſixteen hundred and fifty-five yards.

I have alſo hollow-drained nine acres of my farm, in the bottoms of three pieces of encloſed land, called Small Leafield, Old Land, and Holywell, by the method preſcribed for the third claſs of wet land. Theſe drains were made a few yards below that part of each field where the dry and wet land ſeparate, about twenty-two inches deep, with ſides, and a coverer, of ſtone, and ling on the top of it, to keep the earth from running in. The length of theſe drains is eight hundred and eighty yards, and the expence of labour and materials, three halfpence *per* yard. The drains, in wet weather, diſcharge a large quantity of water; and will, I have no doubt, anſwer the intended

purpoſe. Thus far relates to land in my own occupation.

Nine acres of the land in the Earl of Ayleſford's occupation was almoſt an entire pulp. This bog was of the ſecond claſs, namely, water paſſing through a quick-ſand, and confined by a ſtratum of clay below, and another ſtratum of clay above it. The water thus confined, being preſſed by its fountain, and forced up through the weakeſt parts of the clay, had formed a bog of irregular thickneſs on the ſurface, in ſome places ſix feet deep, in others not more than two. As there is a conſiderable fall in this land, from Eaſt to Weſt, I thought it expedient to put two drains into it; and this appears to me to have been neceſſary, from a conſideration that both theſe drains continue to run in the ſame proportions as when firſt opened. The manner in which theſe drains were executed was, by digging through the different upper ſtrata, and as deep into the clay as the main open drain would admit; then digging or boring through the remaining part of that clay, into the quick-ſand, at the diſtance of about ſix yards, in a progreſſive manner.

The

The water rising rapidly, through these holes, into the close drains, has effected a complete cure of this land, every part of which will now bear a horse to gallop upon it. These drains discharge three thousand six hundred and sixty gallons an hour; which is much less than they did at first, as must be the case in all bogs. This land will be worth twenty shillings *per* acre. The draining cost twenty-five pounds; and the length of the under-ground drains is eight hundred and fourteen yards.

I have just now finished draining another piece of land, about forty-three acres; as this was intended to answer two purposes, one, to drain the land, the other, to give an additional supply of water to a mill-pool, and as a circumstance arose, in the execution of this work, which frequently happens in draining land, namely, a sudden alteration in the position of the under strata, a description thereof will not, I hope, be thought tedious. This draining was begun at the level of a mill-pool, and continued, without any great difficulty, to the distance of about thirty-two chains, in the manner before described as a cure for the

ſecond claſs of boggy land: but, at or near that place, the under ſtrata altered their poſition; the quick-ſand which conveyed the water now became of twice its former thickneſs; and the clay, which had hitherto been above that quick-ſand, for ſome diſtance diſappeared. From the quick-ſand thus becoming ſo much deeper, we could not, with the level of the mill-pool, cut through it; nor indeed, from the wetneſs of the ſeaſon, (November, 1791,) would ſuch an operation have been proper. I therefore continued a ſhallow drain to ſome diſtance, making ſide-holes into the quick-ſand, which ran freely; but, as this could not cure the whole of the bog below, we branched out another drain, (which was made by the method deſcribed for curing the ſecond claſs of wet or boggy land,) by ſinking a cloſe drain through the upper ſtrata into the upper clay, and then, at a ſmall diſtance, on one ſide of this cloſe drain, boring a hole with an auger through the remaining part of that clay into the quick-ſand; and, at every eight yards, as this cloſe drain advanced, ſtill boring other holes, in the manner before deſcribed: through many of theſe

holes

holes the water rufhed with great rapidity. The water difcharged by thefe drains, into the mill-pool, is one hundred and fixty-eight gallons *per* minute, or three thoufand feven hundred and eighty hogfheads in a day; which is after the rate of one million three hundred and feventy-nine thoufand feven hundred hogfheads in a year.

About fix acres of this land were always found; about twelve acres on the north fide were an abfolute pulp, and the remaining twenty-fix acres very unfound. The whole is now found, and will, when cultivated, be worth fixteen fhillings *per* acre. This land would have been drained at a much lefs expence into the main open drain; but then the water, which was much wanted for the mill, would have been loft. Thefe clofe drains are in length one thoufand four hundred and fifty-two yards, and coft one hundred pounds, of which about thirty pounds ought to be charged to the mill.

The foregoing paper is followed by a cerficate, ftating that the circumftances therein mentioned are true.

LVI. *On the Means of giving to Horſes, when drawing in Mills, &c. a Draught perpendicular to the Lever upon the End of which they Act; by M.* Baillet de Belloy.

WITH A PLATE.

FROM THE *JOURNAL DE PHYSIQUE.*

THE power of a horſe, when drawing horizontally, is generally eſtimated as equal to 175 pounds; but, in machines where the horſe is placed at the extremity of the radius of a circle, in which he walks, we muſt not conſider him as poſſeſſing that quantity of power; becauſe the horſe always loſes a greater or leſs portion of his power, on account of his acting more or leſs obliquely upon the lever to which he is harneſſed.

For,

For, ſuppoſe *a k c* (Plate XXIV. Fig. 1.) to repreſent the curve deſcribed by the horſe, at the extremity of the radius *a b*; and ſuppoſe the horſe to occupy the chord *a k*; if *a k* be conſidered as repreſenting the power of the horſe, it is clear that this power is compoſed of *a x*, which is uſeleſs, with reſpect to the motion of the machine, and of *k x*, which only is of any uſe.

It muſt alſo be evident, from the ſame figure, that, in proportion as *a b* is longer, and as the chord *a k*, occupied by the horſe, is ſmaller, *a x* alſo becomes ſmaller, and the value of *k x* becomes nearer that of *a k*: from which this firſt inference may be drawn, *viz.* that the circle in which the horſe walks cannot be too large in diameter. This truth is generally acknowledged.

We may next remark that if, in thoſe caſes where a power is applied which draws in a ſtraight line, the length of the ropes or traces connected to that power is a matter of indifference, and does not alter the quantity of the power, it is by no means the ſame in thoſe caſes where the power acts, and moves on, in a circle; for then, the longer

ger the traces are, the more the chord of the circle occupied by the power varies from being perpendicular to the lever, and the more the power loſes of its force: from which this ſecond inference may be drawn, *viz.* that it is advantageous, in machines which are moved by horſes, to employ ſhort ſtout horſes, and to let their traces be no longer than is abſolutely neceſſary. This length ought not to exceed, except by a few inches, the length of the horſe, from the tail to the breaſt. This ſecond rule ſeems leſs generally underſtood than the former; for I have ſeen, in large and well conſtructed machines, horſes harneſſed in ſuch an improper manner, that the ſuperfluous length of their traces (which was increaſed by the curve of the bar, and the rings which ſerved to faſten the traces to the bar) made them loſe a much greater quantity of their power than they would have loſt in a ſmaller circle, with better-proportioned traces.

It muſt, however, be obſerved, that we cannot always, in our mills, &c. make as large circles for the horſes to walk in as calculation would

direct

direct; want of room, and other œconomical reaſons, often prevent our doing ſo. Calendering machines, hydraulic machines for gardening, mills for preſſing apples, thoſe for oil, flatting-mills, and ſome others, do not allow of a large circle for the horſe; conſequently, in all of them, a ſenſible proportion of the horſe's power is loſt.

Deſaguliers ſays, (Courſe of Experimental Philoſophy, Vol. I.) that, in a foot-way of forty feet, five men are equal to a horſe; but that, in a foot-way of nineteen feet, three of theſe men would be able to puſh forward a horizontal lever, which could not be drawn by a horſe, though equal in other circumſtances to five men.

But, even in the largeſt circles, as the horſe occupies a chord of the circle, not a tangent, he always loſes a certain portion of his power; which, though leſs than in ſmaller circles, is nevertheleſs of ſome conſequence. I have endeavoured to annihilate this loſs entirely, in all machines, whatever may be the diameter of their foot-way; and I think I have diſcovered the method of doing it. This method is, to place the horſe under the lever, in ſuch a manner that the

lever is exactly in the middle of the horſe, meaſured from the tail to the breaſt. The horſe, thus ſituated, keeps the ſame poſition, with reſpect to the lever, in every point of the circle he deſcribes; he always croſſes it at right angles; he always occupies a tangent of the circle; in ſhort, he always exerts the whole of his power in giving motion to the machine.

In order to place the horſe in this ſituation, and to harneſs him in an eaſy and commodious manner, various contrivances may be made uſe of. That which is ſeen at Fig. 2, conſiſts of two upright pieces or arms, *a b*, *a b*, firmly fixed to the lever *c d*. The horſe is to be placed between theſe arms or vertical ſhafts, and the traces, the length of which ſhould be juſt equal to half the length of the horſe, are to be faſtened to the rings or hooks *e e*, at the bottom of the arms.

This conſtruction may be convenient in thoſe caſes where the horſe goes always one way, and never has occaſion to turn the contrary way.

The other modes of conſtruction, repreſented in Figs. 3 and 4, are applicable to thoſe machines

in

in which the horſe, after having made a certain number of revolutions in one direction, is obliged to turn about, to go the contrary way.

The vertical ſhafts of Fig. 3. are made of wood; thoſe of Fig. 4. are of iron; and both are movable upon the pins *e f*. The horſe is to be placed between theſe ſhafts, and to be harneſſed in the ſame manner as before deſcribed.

It is hardly neceſſary to ſay that, as the horſes ſucceſſively applied to work a machine may not all be of the ſame ſize, it is of conſequence that we ſhould be able to ſhorten or lengthen the traces; and alſo to raiſe or lower the part to which the traces are fixed, in ſuch a manner that the horſe ſhall always draw perfectly horizontally. Means for executing theſe two purpoſes may be very eaſily contrived.

Explanation of the Figures.

(See Plate XXIV.)

Fig. 1. *a k c.* Circle deſcribed by the horſe.

a b. Radius of the circle.

a k. Chord of the circle occupied by the horſe.

Fig. 2. *c d.* Horizontal lever or beam of the mill.

a b, a b. Vertical ſhafts, between which the horſe is to be placed.

e e. Hooks or rings, to which the traces are to be faſtened.

Fig. 3. *a b c d.* Vertical ſhafts, formed of two pieces of wood joined at *a c* by iron hoops; they are movable about the pin *e f.*

g h. Horizontal lever.

i. Upright axis of the mill.

Fig. 4. *a b c d.* Vertical ſhafts made of iron.

e f. Pin or axis of the ſhafts.

g h. Horizontal lever.

Fig. 1

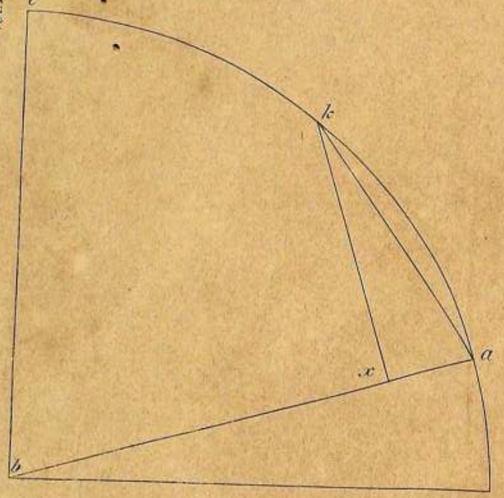


Fig. 2

Fig. 3

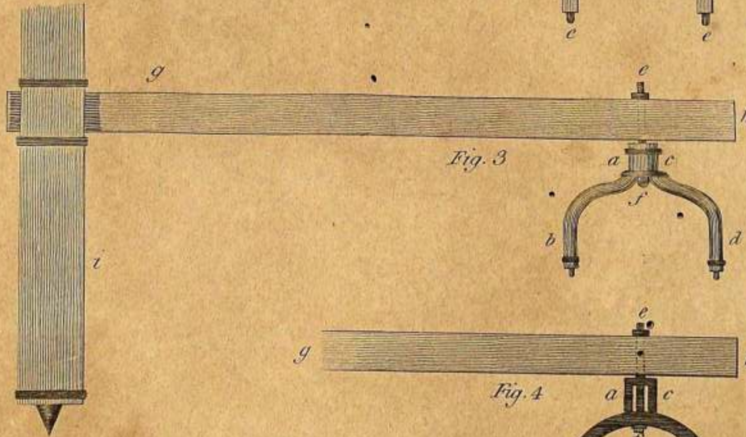
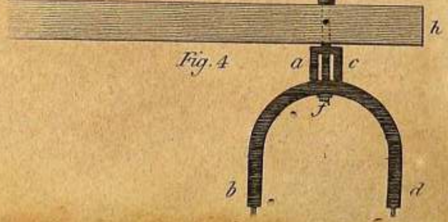


Fig. 4



LVII. *Conclusion of* M. MONGE's *Observations on the Mechanism of Felting.*

(FROM p. 360.)

THE operation of fulling woollen cloths has so much affinity with that of felting, that I think it may not be improper in this place to make some observations upon it.

The asperities with which the surface of wool is every where surrounded, and the disposition which it has to assume a progressive motion towards the root, render the spinning of wool, and making it into cloth, difficult operations. In order to spin wool, and afterwards to weave it, we are obliged to cover its fibres with a coating of oil, which, filling the cavities, renders the asperities less sensible; in the same way as oil, when rubbed over the surface of a very fine file, renders it still less rough. When the piece of cloth is

is finiſhed, it muſt be cleanſed from this oil; which, beſides giving it a diſagreeable ſmell, would cauſe it to ſoil whatever it came in contact with, and would prevent its taking the colour which is intended to be given to it by the dyer. To deprive it of the oil, it is carried to the fulling-mill, where it is beat with hammers in a trough full of water, in which ſome clay has been mixed; the clay combines with the oil which it ſeparates from the cloth, and both together are waſhed away by the freſh water which is brought to it by the machine; thus, after a certain time, the oil is entirely waſhed out of the cloth.

But the ſcouring of the cloth is not the only object in fulling it; the alternate preſſure given by the mallets to the piece of cloth occaſions, eſpecially when the ſcouring is pretty far advanced, an effect analogous to that which is produced upon hats by the hands of the hatter; the fibres of wool which compoſe one of the threads, whether of the warp or the woof, aſſume a progreſſive movement, introduce themſelves among thoſe of the threads neareſt to them, then into

thoſe

those which follow; and thus by degrees all the threads, both of the warp and the woof, become felted together. The cloth, after having, by the above means, become shortened in all its dimensions, partakes both of the nature of cloth, and of that of felt; it may be cut without being subject to ravel, and, on that account, we are not obliged to hem the edges of the pieces of which clothes are made. Lastly, as the threads of the warp and those of the woof are no longer so distinct and separated from each other, the cloth, which has acquired a greater degree of thickness, forms a warmer cloathing. Knit worsted also is, by fulling, rendered less apt to run, in case a stitch should drop in it.

The *Ægagropilæ* or hair-balls, which are often found in the stomachs of certain animals which lick themselves, are nothing more than masses of hair, or wool, which the motion of the stomach has felted; and which have become more and more compact, in proportion as they have increased in size, by the accumulation of fresh hairs which have successively attached themselves to the ball.

The

The application of the folution of mercury in *aqua fortis*, as before defcribed, to that hair which is intended to be made into hats, is a very unwholefome operation to the workmen who are employed in it, on account of the mercurial vapours, which they cannot help breathing; it would therefore be a very ufeful object of enquiry, to endeavour to afcertain what particular alteration the mercurial folution produces in the hair by its application; or to try to produce the fame alteration, or any other, provided its effect were the fame with refpect to felting, by means of fubftances, the ufe of which would not be unwholefome.

END OF VOL. III.

INDEX

TO THE

THIRD VOLUME.

A

	Page
ACID, on the effects of vitriolic and nitrous, compounded,	179
—— nitrous. On the alteration of iron by it -	328
Acids. On the diſſolution of metals in them, 177. 262.	325
Ægagropilæ. How formed in the ſtomachs of animals,	431
Angell, Mr. Albert. Patent for Britannic elaſtic gum,	381
Animal matter, contained in wheat and maize, -	392

B

Baillet de Belloy, M. On giving to horſes, in mills, &c. a perpendicular draught, - -	422
Batting cotton and wool, patent machine for, -	145
Baumé, M. Deſcription of a mill to grind potatoes, &c.	62
Blaikie, Mr. Francis. Patent for a ſubſtitute for gum,	73
Boats which will neither overſet nor ſink, patent for,	10
Bramah, Mr. Joſeph. Patent for improvements and additions to a fire-engine, - -	368
Bricks, &c. on a new principle, patent for -	84
Briſſon, M. On the kind of ſteel moſt fit for receiving magnetic power, - -	276
Bucknall, Thomas Skip Dyot, Eſq. Obſervations on pruning orchards, - - -	31

Page

C

Canals, navigable. Patent for locks for them, - 303
Carding cotton. Method of preventing injury to thoſe employed in that operation, - 162
Cartwright, Edmund, M. A. Patent for bricks, &c. on a new principle, - - - 84
Chamber lamp-furnace. Account of one, - - 24
Character, univerſal, farther conſiderations on, - 91
Chimneys. Method of ſweeping narrow ones, without employing children, - - 322
Clock. Account of one, - - - 260
Coke-ovens. Patent for adapting their heat to various purpoſes, - - - - 75
Connop, Mr. Thomas. Patent for a machine for batting cotton and wool, - - - 145
Conway, the Right Honourable Henry Seymour. Patent for adapting the heat of coke-ovens to various purpoſes, - - - 75
Cooke, John, Eſq. Deſcription of a ſteam-engine, - 401
Cooking. On improving the veſſels uſed for that purpoſe, 134. 194
Copper. On ſeparating ſilver from it, - - 190
——— *veſſels.* Manner of enamelling them, - 141
——— *plate printing,* patent for making paper for, 377
Cort, Henry, Eſq. Patent for preparing, welding, and working, various ſorts of iron, &c. - 289
——————— Patent for ſhingling, welding, and manufacturing, iron and ſteel into bars, plates, &c. 361
Cotton. Patent for a machine for batting it, - 145
——— Method of preventing injury to thoſe who card it, 162
——— *cloth,* ſpontaneous inflammation of, - 21
Couret, M. Method of preparing Naples yellow - 349
Crane. Deſcription of one for wharfs, - - 113
Croſthwaite, Mr. John. Deſcription of two pendulums, and a clock, &c. - - - 254

Culinary

Page
Culinary vessels. Patent for tinning them, - - 12
Cylinder. Patent for working Pumps, &c. by one, - 220

D

Davies, Mr. Thomas. Observations on watering meadows, - - - - 43. 123
Dearborn, Mr. Benjamin. Description of a pump-engine, 119
———— Description of a fire-engine, 174
Deight and Roberts, Messrs. Patent for laying oil colours in a way not yet known, - - 159
Dough. Machine for kneading it, used at Genoa, - 283
Draining-land, observations on, - - 405

E

Elastic gum, Britannic. Patent for, - - 381
Enamelling copper vessels, manner of, - - 141
———— iron vessels, manner of, - - 206

F

Felting, on the mechanism of, - - 351. 429
Fire-engine. Apparatus to answer the purpose of one, 119
———— Description of one, - - 174
———— Patent for improvements and additions to one, 368
Fishwick, Mr. Richard. Patent for making white-lead, 225
Flax-seed. Its use as a substitute for gum, - - 74
Flour, on making, from potatoes, - - 67
Fulling, observations on, - - - 429
Fultin, Mr. William. Patent for working pumps, &c. by a cylinder, - - - 220

G

Gum. Patent for a substitute for it, - - 73
—— *elastic, Britannic,* patent for, - - 381

Page

H

Hair. Deſcription of its texture, - - 351
—— *balls*, how formed in the ſtomachs of animals, 431
Heights, inſtrument for taking, - - 234
Hemp, ſpontaneous inflammation of, - - 19. 101
Hooper, Mr. Samuel. Patent for making printing-paper, 377
Horſes. On giving them a perpendicular draught, - 422

I

Inflammations, ſpontaneous, account of, - 19. 21. 95
Inſtrument for taking heights, - - - 234
Iron. On the precipitation of ſilver by it. - 271
—— On its alteration by a ſolution of ſilver, &c. - 328
—— Patent for working it, - - - 289. 361
—— *pots.* Patent for caſting them, - - 231
—— *veſſels.* Manner of enamelling them, - 206
Irrigation, obſervations on, - - - 43. 123. 236

J.

Jackſon, Mr. Humphrey. Patent for beautifying and preſerving wood, - - - 316
Jeſſop, W. Eſq. On reſervoirs for flood-waters, - 243

K

Keir, James, Eſq. Experiments and obſervations on the diſſolution of metals in acids, &c. - 177. 262. 325
Keith, Alexander, Eſq. Deſcription of a mercurial level, 338
Kneading dough, machine for, - - 283
Knot in a hair, method of untying, - - 354

L

Lamp-black, ſpontaneous inflammation of, - 104
—— *furnace.* Account of one, - - - 24
Lamps which will bear motion, patent for, - 151
Land. On watering it, - - - 43. 123. 236

Land.

Page

Land. On draining it, - - - 405

Language univerſal, remarks on, - - 91

Leather, patent for tanning, and making, - 217

Level. Deſcription of a mercurial one, - - 338

Locks for navigable canals, patent for, - - 303

Lukin, Mr. Lionel. Patent for boats which will neither overſet nor ſink, - - - 10

M

Magnetic power. On the kind of ſteel moſt fit for receiving it, - - - - 276

Meadows. On watering them, - 43. 123. 236

Meaſures, on obtaining ſtandards for, - 165

Mechanical machines. Patent for working them by a cylinder, 220

Mercurial level. Deſcription of one, - 338

Metals. On their diſſolution and precipitation, 177. 262. 325

Miles, Mr. John. Patent for lamps which will bear motion, 151

Mill. Deſcription of one to grind potatoes, - 62

Mills. On giving to horſes who draw in them a perpendicular draught, - - 422

Monge, M. On the mechaniſm of felting, - 351. 429

More, Samuel, Eſq. Attempt to obtain practical ſtandards for weights and meaſures, - - 165

Mortar for buildings, patent for, - - 1

N

Naples yellow, method of preparing, - - 349

Northmore, Thomas, Eſq. Farther conſiderations on the pangraph, - - - 91

O

Oil-colours, patent for laying, in a way not yet known, 159

Oils, ſpontaneous inflammation of, - 19. 21. 100. 104

Orchards. On pruning them, - - 31

P *Paint.*

P

Page

Paint. Patent for laying it in a way not yet known, - 159

Pangraph, farther considerations on, - - 91

Pearson, George, M. D. Experiments and observations on the potatoe-root, - - 383

Pendulums, description of, - - 15, 254. 257

Pentrough for equalizing water on water-wheels, - 343

Perceval, Robert, M. D. Account of a chamber lamp-furnace, - - - 24

Phlogistication, effect of, on a mixture of vitriolic and nitrous acids, - - - 262

Pine, the Rev. J. Description of a pendulum, - 15

Pitt, William, Esq. On irrigation, or watering land, &c. 236

Playfair, Mr. J. Patent for locks for navigable canals, - - - - 303

Potatoes. Mill for grinding them, - - 62

——— On making starch or flour from them, - 67

——— On their constituent parts, - - 383

Pots, iron. Patent for casting them, - - 231

Poulain, Mr. John. Patent for tinning vessels, - 12

Printing-paper, patent for making, - - 377

Pruning, observations on, - - - - 31

Pump-engine. Description of one, - - 119

Pumps. Patent for working them by a cylinder, - 220

Q

Quayle, George, Esq. Description of a pentrough for equalizing water on water-wheels, - 343

R

Reservoirs for flood-waters, observations on, - 240

Rinman, Mr. Sven. On improving the vessels used in cooking, - - - 134. 194

Page

Roberts and Dight, Messrs. Patent for laying oil-colours in a way not yet known, - - 159

Rubbing-boards. Patent for working them by a cylinder, 220

Rye-bran, spontaneous inaflmmation of, - - 97

S

Sail-cloth, spontaneous inflammation of, - 100

Saucepans, iron, patent for casting, - - 231

Shot, patent for making, - - - - 313

Silver. On separating it from copper, - - 190

—— On its precipitation by iron, - - 271

—— On the alteration of *iron* by a solution of it, 328

Soot, spontaneous inflammation of, - - 104

Spontaneous inflammations, account of, - 19. 21. 95

Starch. On making it from potatoes, - - 67

Steam-engine. Description of one, - - 401

Steel. On the kind most fit for receiving the magnetic power, - - - 276

—— Patent for manufacturing it into bars, - 361

—— *edged instruments*, powder for polishing and sharpening, 316

Stucco, patent for, - - - - 1

T

Tanning, patent for, - - - - 217

Taylor, Mr. Jonathan. Patent for casting, nealing, tinning, and finishing, iron pots, &c. - 231

Tinning, patent for, - - - 12

Tooke, the Rev. William. Observations on spontaneous inflammations, - - - 95

Toplis, Mr. Samuel. Description of a method of vein-marbling silk, &c. - - 319

Tucker, Mr. John. Patent for tanning and making leather, 217

V *Vein-*

V

Page

Vein-marbling ſilk, &c. Method of, - - 319

Veſſels which will neither overſet nor ſink, patent for, 10

—— On improving thoſe uſed in cooking, - 134. 194

W

Watering meadows, obſervations on, - 43. 123. 236

Water-wheels. Pentrough for equalizing the water falling on them, - - - 343

Watts, Mr. William, Patent for making ſmall-ſhot, 313

Wedge, Mr. John. Obſervations on draining land, - 405

Weights, on obtaining ſtandards for, - - 165

Wharfs, deſcription of a crane for, - - 113

Wheat, conſtituent parts of, - - 392

White, Mr. James, Deſcription of a crane for wharfs, 113

White-lead, patent for making, - - - 225

Williams, Richard, M. D. Patent for mortar or ſtucco, 1

Wood. Patent for beautifying and preſerving it, - 316

Wool, ſpontaneous inflammation of, - - 98

—— Patent machine for batting it, - - 145

Y

Yellow, Naples. Method of preparing it, - 349